WESTON®

DIGITAL MULTIMETER

MODEL 1242

INSTRUCTIONS / PARTS LIST

ERRATA SHEET

MODEL 1242

DIGITAL MULTIMETER

Instruction Manual F-3732 R1

Page 29. TABLE 11. Last line - AC Voltage Input 500.0V, Readout Limits 40Hz. Delete 499.3 Min. 500.7 Max. and substitute "498.3 Min. 501.7 Max."

WESTON INSTRUMENTS, INC.
614 FRELINGHUYSEN AVENUE, NEWARK, N. J. 07114
WESTON
Schlumberger

INSTRUCTIONS WITH PARTS LIST

FOR

WESTON
MODEL 1242

DIGITAL MULTIMETER

U.S. PATENT 3,051,939
and Patents Pending

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WESTON INSTRUMENTS, INC.
614 FRELINGHUYSEN AVENUE, NEWARK, N. J. 07114

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F–3732 R1

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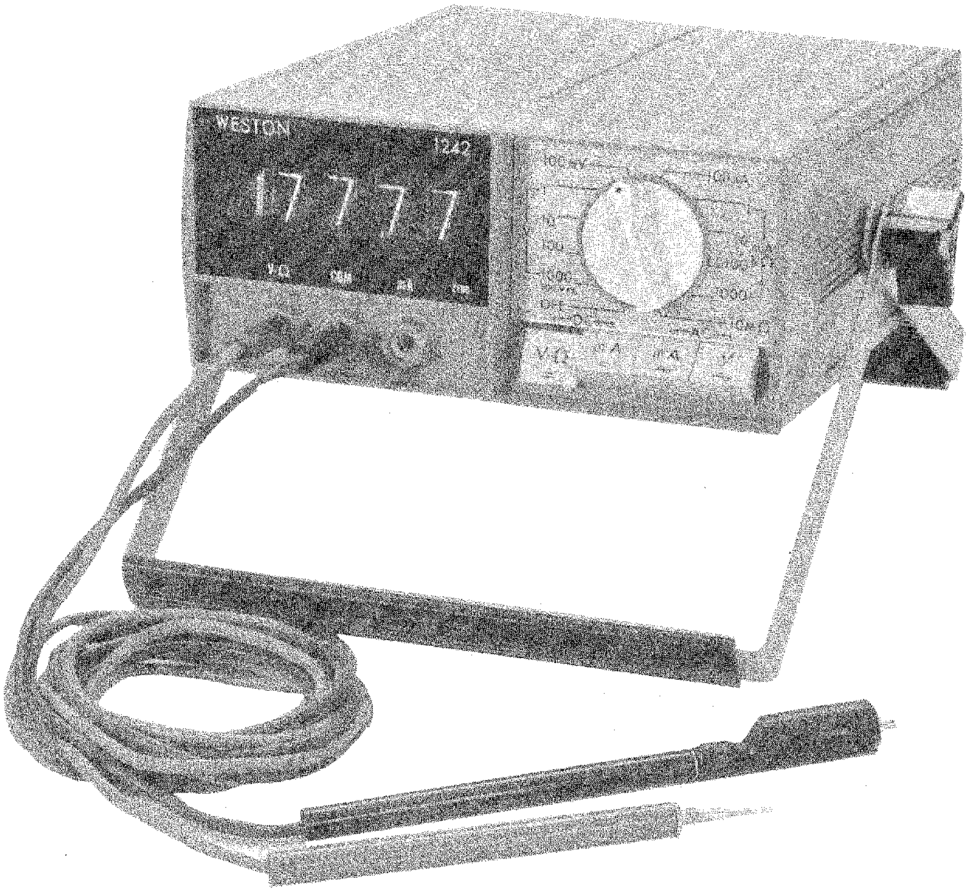


Figure 1. Model 1242 Digital Multimeter with Handle/Stand and Test Probes

GENERAL INFORMATION

DESCRIPTION

The Weston Model 1242 is a compact digital multimeter designed for maximum operator convenience and utility. Five voltage and five current ranges, both AC and DC, as well as five resistance ranges are self-contained in a high-impact resistant plastic case.

The basic measuring circuit is a bipolar analog to digital converter which employs dual-slope integration to achieve excellent accuracy and long term stability. Full scale display is 10,000 digits and an overrange capability to 19,999 digits is provided, except where limited by overload. The basic measurement range is 4 volts DC. All ranges and functions are converted to the basic 4 volt DC range for measurement as a DC voltage.

A custom-designed thin-film attenuator and a switched-gain preamplifier extend DC voltage measurements from 100mV F.S. to 1000V F.S.

AC voltage is converted to DC by an average – sensing, RMS – calibrated, operational rectifier which extends the AC voltage range from 100 millivolts full scale on the most sensitive range to an allowable maximum of 500 volts on the highest range.

Current is measured by the voltage drop it establishes across a precision shunt network. If DC – it is measured directly; if AC – it is first converted to DC by the operational rectifier. Currents from 0.1 microampere to 1 ampere can be measured with a voltage drop of only 100 millivolts full scale across the shunt.

Resistance is measured by passing a scaled constant current through the unknown and measuring the DC voltage across it. Resistance ranges from 1K ohms to 10 megohms are provided with a measuring current of no more than 100 microamperes.

The mechanical design of the instrument has stressed operator convenience and confidence in its straight-forward control/connector layout and generous overload protection. Easy portability is evident, too, in its small size, fully recessed controls, and connectors, and its battery pack compatibility for field use.

Carrying handles serve a dual purpose as a tilt-stand for any viewing angle during table top operation. The instrument may be panel mounted without any additional parts.

Optional accessories include a leather carrying case.

Power requirements are 115VAC or 230VAC at frequencies of 50/60/400Hz, 10 watts, nominal.

SPECIFICATIONS

Size .... 3" high x 7" wide x 7.9" deep

Weight .... Approx. 4.5 pounds (2 kg)

Display .... Maximum Count: 19999
Overrange Indication: Automatic (beyond 19999)
Polarity Indication: Automatic (for negative DC)
Reading Rate: 10 per second, non-blink (100 millisec integration time).
Numeric Display by side-viewing neon glow tubes with integral decimal points.

Power Requirements . . 115VAC or 230VAC
Tolerance: +15%, −10%
Line Frequency: 50Hz to 400Hz
Power Drain: 10 watts nominal

Accessories . . . . Combination carrying handle tilt-stand — standard on all units.
Leather carrying case — optional

Additional Features . . Input protection fuse accessible from outside of unit. May be operated 500 volts above power line ground. Common terminal may be operated no more than ±500 volts away from power line ground or neutral. See DC Voltage Measurement paragraph under Operation section for precautions to be observed when monitoring isolated sources.

Operating Temperature . . 10°C to 40°C

DC VOLTS (at 23°C ±1°C and line voltage of 115V/230V ±10%)

Range	Zin	Rated Accuracy	Input Protection Limit
100mV	≥100 MΩ	±0.05% rdg ±2 digit*	500V rms
1V	≥1000 MΩ	±0.05% rdg ±1 digit	500V rms
10V	10 MΩ	±0.05% rdg ±1 digit	1000V peak
100V	10 MΩ	±0.05% rdg ±1 digit	1000V peak
1000V	10 MΩ	±0.05% rdg ±1 digit	1000V peak

* May be zeroed out for best accuracy.

Overrange Capability . . . . 100% (to 19999) on all ranges except the 1000V range where the allowable limit is 1000V DC.

Resolution . . . . 10 microvolts

Full Scale Step Response (to within 0.05% of final value) . . 0.5 sec.

Input Bias Current . . . 2nA maximum at 25°C

Temperature Influence . . . . . ±40 PPM Rdg ±0.4 digit/°C

Normal Mode Rejection . . . . . 40 dB minimum at 60Hz

Common Mode Rejection . . . . . 80 dB minimum with 1K unbalance at 60Hz

RESISTANCE

Range	Test Current	Rated Accuracy	Input Protection Limit
1K	100 µA	±0.15% rdg ±1 digit	130V rms, continuous
10K	100 µA	±0.10% rdg ±1 digit	230V 30 sec. max.
100K	10 µA	±0.10% rdg ±1 digit	250V rms
1MΩ	1 µA	±0.25% rdg ±1 digit	250V rms
10MΩ	0.1 µA	±0.5% rdg ±1 digit	250V rms

Overrange
Capability .... 100% (to 19999) on all ranges

Resolution .... 0.1 ohm

Full Scale
Step Response . less than 1 second except the 10MΩ range where response time is six seconds at 10MΩ.

NOTE: Short term accuracy immediately after overload may exceed specifications, but instrument will recover to within rated accuracy.

AC VOLTS (mean sensing, RMS Calibrated)

Range	Zin	Input Protection Limit
100mV	1MΩ	250V rms
1V		250V rms
10V		500V rms
100V		500V rms
1000 (500V, max.)		500V rms

Accuracy ..... 0.2% rdg ±.05% F.S., 60Hz to 10KHz all ranges
0.25% rdg ±.05% F.S. to 40Hz
0.5% rdg ±.15% F.S. to 20KHz

Overrange
Capability .... 100% (to 19999) on all ranges except the 1000V range where the maximum allowed is 500VAC.

Resolution .... 10 microvolts

Full Scale
Step Response . Three seconds, maximum, (to within 0.2% of final value)

DC AMPS

Range	Voltage Drop (nom.)	Accuracy
100μA	0.1 Volt	±0.15% rdg ±1 digit
1mA	0.1 Volt	±0.15% rdg ±1 digit
10mA	0.1 Volt	±0.15% rdg ±1 digit
100mA	0.1 Volt	±0.15% rdg ±1 digit
1A	0.1 Volt	±0.20% rdg ±1 digit

Overrange
Capability .... 100% (to 19999) on all ranges

Input Protection
Limit .... 3 Amps, any range, by fuse and clamp diodes

Resolution 10nA

Full Scale Step Response (to within 0.05% of final value) ..... 0.5 sec.

AC AMPS (40Hz to 10KHz)

Range	Voltage Drop (nom.)	Rated Accuracy
100μA	0.1 Volt	0.35% rdg ±0.05% FS
1mA	0.1 Volt	0.35% rdg ±0.05% FS
10mA	0.1 Volt	0.35% rdg ±0.05% FS
100mA	0.1 Volt	0.35% rdg ±0.05% FS
1A	0.1 Volt	0.4% rdg ±0.05% FS

Overrange Capability .... 100% (to 19999)
Input Protection Limit . 3A (by fuse and clamp diodes)
Resolution 10nA
Full Scale Response .... three seconds maximum

INSTALLATION

GENERAL

Inspect the instrument for possible damage in shipment. If damage is noted, notify the carrier and supplier before using the instrument.

CARRYING HANDLES

Remove the carrying handles and knobs from the accessory container. Mount handles to the case as shown in Figure 2. The knobs differ at their threaded ends and may be used on either side of the case. When oriented for carrying, both handles should be rotated to the front of the case, at which point their detents will lock and may be secured by tightening the knobs.

JUMPER CONNECTOR

A twenty terminal jumper connector has been provided in the accessory kit. Mount it on the card edge connector at the rear of the instrument near the lower edge. Observe orientation markings, and secure in place with its captive screw.

TILT-STAND OPERATION

For bench or table top use, the handles should be locked in the open position shown in Figure 2. Two stable orientations of the handles are possible, each providing a different height off the table. In one position the inner handle is forward; in the second, it is to the rear.

It is important that the detents on the handles be engaged when in the tilt-stand position in order to provide maximum stability.

PANEL MOUNTING

The instrument has been provided with an option for mounting on a 1/8 inch panel. Special mounting screws have been provided in the accessory kit and the panel cut-out dimensions are given in Figure 3.

In mounting the instrument on a prepared panel, the circuit board inside the case must be repositioned forward by 1/8 inch. To perform this modification without damage to the instrument, the following instructions should be carefully followed. (See Figures 4 and 5.)

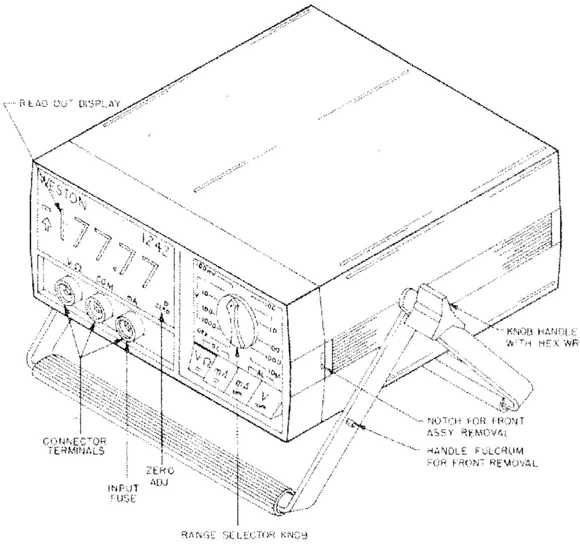

READ OUT DISPLAY
WESTON
1242
COM
mA
ZERO
KNOB HANDLE ASSY WITH HEX WRENCH
NOTCH FOR FRONT ASSY REMOVAL
HANDLE FULCRUM FOR FRONT REMOVAL
CONNECTOR TERMINALS
ZERO ADJ
INPUT FUSE
RANGE SELECTOR KNOB

Figure 2. Handle/Stand Assembly

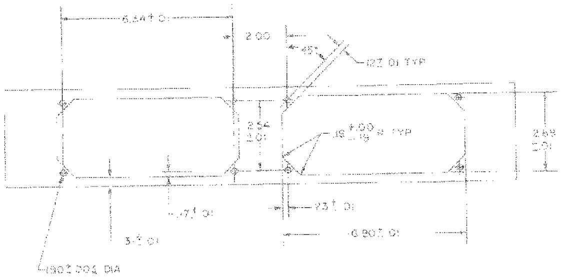


Figure 3. Panel Cut-Out Dimensions

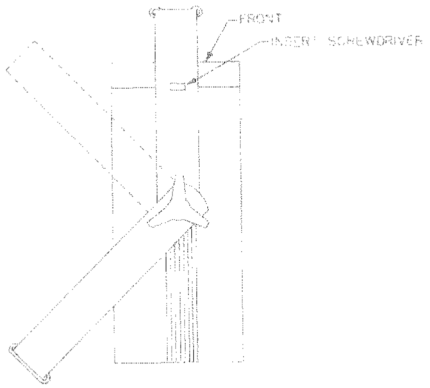


Figure 4. Removal of Front Assembly Using Handle/Stand as Fulcrum

CAUTION

Before proceeding, all push buttons must be in the UP position and must remain up until modifications and mounting are completed. The buttons may be restored to the UP position by depressing two buttons simultaneously.

1. Stand case on back end with inner handle locked in the front position as shown in Figure 4.
2. The front may now be removed. Starting on one side, insert 1/8 inch screwdriver blade, through rectangular hole provided in inner handle and into notch in front. Using handle as a fulcrum, gently pry front upwards. It will snap into a new position, 1/8 inch forward. Repeat on the other side. Now reset screwdriver blade 1/16 inch lower on front to engage edge of front. Pry up front one more notch on each side. The front will now come free.
3. Before pulling off front, swing handle clear of front and reset in table top position.
4. Facing the instrument's front, gently pull front forward, maintaining care that switch contacts behind push buttons are not damaged. Switch shaft may come out with front. Lay front down on table.
5. Remove shaft from front and replace it in rotary switch assembly.
6. Leads may now be removed from front and front put aside temporarily. Note the interconnections to reconnect correctly. (See Figure 23).
7. The handles may now be removed.

8. To remove the circuit board, rotate two screws at rear of case 1/2 turn counterclockwise. This will rotate two clamps freeing board from case. (See Figure 5.) Remove edge connector guard.
9. Grasp circuit board from front of case and remove. This can be assisted by pushing on rear of circuit board at edge of accessory connector.
10. The board must be advanced 1/8 inch forward in case to allow for panel mounting clearance. One-eighth inch spacers have been provided on the tube clamp. Remove tube clamp and break off L-shaped spacers at its rear edge. (See Figure 5.) Trim spacer edge with razor blade.
11. Slip spacers onto rear of circuit board behind the rectangular cutouts in space marked PANEL. Orient spacers with cutout side down. Secure them in place with a small amount of cement such as pliobond. When properly positioned, none of the word PANEL will be visible.
12. Advance circuit board mounting clamps by 1/8 inch to engage the new position of cutout. Rotate clamp screws at rear counterclockwise about 6 turns until both clamps can be rotated past the stops built into case.
13. Insert circuit board into case making sure that clamps can slide into cutouts on circuit board in this new position.
14. Slide out circuit board one-third of its length and reinsert tube clamp in back of display tubes and into the slides provided within case.
15. Slide circuit board all the way back into case and secure by rotating screw clamps.
16. The case may now be mounted into prepared panel by means of the screws and inserts provided at front of case.
17. Leads may now be connected to front. Be cautious that the switch contacts are not damaged in the process.
18. Front panel may now be reinstalled on case. Observe that all buttons are up and that notch in range knob lines up with spline on switch shaft.

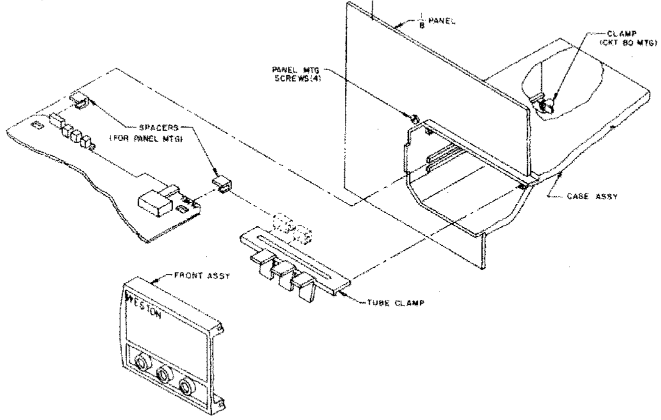


Figure 5. Panel Mounting (Optional)

POWER REQUIREMENTS

The Weston Model 1242 has been designed to operate on 115VAC or 230VAC, 50Hz to 400Hz. A rear panel switch permits operation in either mode. Be sure that the switch is in the proper position for the local power lines before applying power. If 115VAC is applied in the 230 volt position, only a faint display will occur. If 230VAC is applied in the 115VAC position, a rear panel fuse will blow out. The line voltage ratings of this instrument will permit it to extend to 15% above or 10% below nominal line voltage.

The instrument is equipped with a three conductor power cable that grounds the instrument when plugged into a suitable outlet. To preserve this feature when operating with a two contact outlet, use an adapter and connect the pigtail on the adapter to a suitable ground. (See Figure 8, rear panel description for further details.)

OPERATION

FRONT PANEL DESCRIPTION

1. Range Switch
   - a. Applies AC power to instrument. ON is any position but OFF.
   - b. Permits range selection for AC or DC Voltage or Current when switch to V–mA, in conjunction with push button function switch.
   - c. Permits ohms range selection when switch to ohms positions, in conjunction with V–Ω push button switch.
2. Function Push Button Switches
   - a. Permits, in conjunction with range switch, the measurement of DC volts or ohms.
   - b. Permits, in conjunction with range switch, the measurement of DC current.
   - c. Permits, in conjunction with range switch, the measurement of AC current.
   - d. Permits, in conjunction with range switch, the measurement of AC volts.
3. Input V–Ω jack (left) and COM jack (center) are inputs for AC and DC volts and ohms.
4. Input mA jack (right) and COM jack (center) are inputs for AC and DC current.
5. Zero adjustment.
6. Display
   - a. Four cold cathode numeral tubes with internal decimal points. Decimal point is automatically determined by the range switch.
   - b. An overrange digit to carry ten-thousands digits information. This will either indicate "1" or not at all.
   - c. A "–" polarity indicator to automatically indicate polarity of input for DC volts and milliamperes; it reads "–" for negative DC measurements and remains inactive for AC measurements, ohms and positive DC.
   - d. An outrange lamp, in the shape of an arrow, indicates an input beyond 19999, in which region the display is locked at 0000. This instructs the operator to shift to a higher range setting.

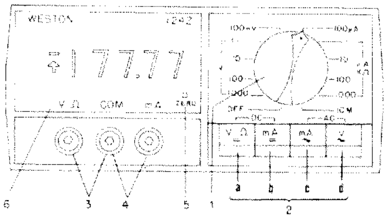


Figure 6. Front Panel Description

INPUT OVERLOAD PROTECTION

All input circuits are protected against input overload by generous margins as given under SPECIFICATIONS. The voltmeter input circuit uses resistive dissipation in conjunction with diode connected transistors to limit the voltage to the input amplifier. The OHMS circuit also uses resistive dissipation. The CURRENT circuit protects its shunts by a diode network and the diodes by a fuse. The current circuit fuse, 3 Amp 8AG, is located behind the mA input jack. It is removable with a wrench built into one of the knob handles.

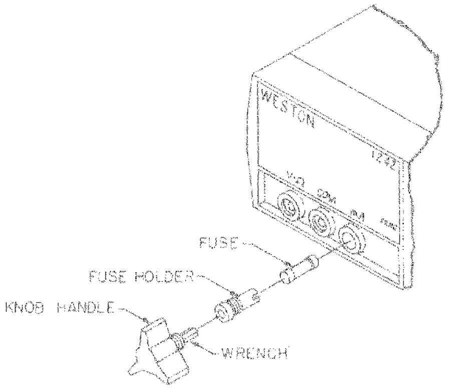


Figure 7. Input Fuse Replacement

REAR PANEL DESCRIPTION

1. Line voltage selector is a two position slide switch. Left position is for 115 volt power line operation. Right position is for 230 volt power line operation.
2. AC Power line connector is a three pin recessed male connector. The right hand pin supports a 1/4 amp. 8AG fuse. It is removed with the aid of the small wrench designed into the tip of one of the tilt-stand knobs.
3. A card edge connector. The jumper connector provided in the accessory kit should be installed on the card edge connector and secured in place with the captive screw.
4. Four adjustments (ohms calibration, +V, −V, 20MΩ) are provided for periodic standardization. See Maintenance Section.
5. Screw-clamps used for securing circuit board.

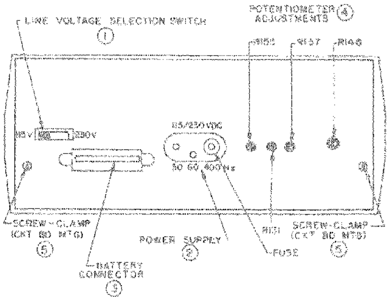

LINE VOLTAGE SELECTION SWITCH ①
POTENTIOMETER ADJUSTMENTS ④
R155
R157
R148
115V
230V
115/230VAC
50 60 400Hz
SCREW-CLAMP (CKT BD MTG) ⑤
POWER SUPPLY ②
R151
SCREW-CLAMP (CKT BD MTG) ⑤
FUSE
BATTERY CONNECTOR ③

Figure 8. Rear Panel Description

DC VOLTAGE MEASUREMENT

1. Set LINE VOLTAGE SELECTOR switch, on rear panel, to proper line voltage position, and check that jumper plug is on rear card-edge connector.
2. Plug instrument power cord into AC power outlet.
3. Set RANGE switch to 1000V.
4. Depress FUNCTION push button DC (V−Ω) to DOWN position.
5. Allow 15 minutes warm-up for stabilization to insure best accuracy.
6. Connect test leads to jacks marked V−Ω and COM.
7. Short test leads and set RANGE switch to 10V. Display should read zero (00.00). If not, rotate the zero control to achieve this. After this is done, a small residue of about 2 digits may be observed with the input shorted on the 100mV range. It may be zeroed out for critical measurements.

NOTE

If the input leads are left open-circuited on the 100mV or 1V ranges, the display reading will slowly increase due to the presence of a small current appearing across the high input impedance of the preamplifier. A similar effect occurs on any range if all the push buttons are up. On the 10, 100, and 1000 volt ranges, the reading will remain at zero.

8. Set range switch to 1000V, apply input and observe reading. If readout exceeds 1000V remove input immediately as an overload condition exists. Otherwise, reduce range switch setting until the proper range is reached. Table 1 indicates proper readout limits for each range. While the instrument will perform to specification below 2000 digits, best performance will be obtained by readjusting to a more sensitive range when the reading goes below the limits shown.

TABLE 1. DC VOLTAGE READOUT LIMITS

Range	Proper Readout Limits
100mV	00.00 – 199.99
1V	.1999 – 1.9999
10V	1.999 – 19.999
100V	19.99 – 199.99
1000V*	199.9 – 1000.0

*Note that while all lower ranges have a 100% overrange capability, the 1000V range is limited by breakdown consideration to 1000V.

CAUTION

Do not operate the meter with more than 500 volts common mode or damage to the instrument may result. When monitoring sources greater than 500 volts where one terminal is at line ground or neutral potential, that terminal should be connected to meter COMMON. Many commercial isolated power supplied if left ungrounded are capable of producing excessive common mode voltages when operating with greater than 500 volts output under certain conditions. In figure 9A, representing a typical calibrator, a large 0.1μF capacitor is often provided from (–) output terminal to ground. The other capacitor is figure 9A represents stray in the instrument from (+) output terminal to ground. If the calibrator has its (+) positive terminal connected through (S) to common (–) of the instrument and its negative terminal connected to (V – Ω) input of the instrument, the output of the calibrator will appear as a common mode signal to the instrument. When switch (S) is closed and the output of the supply is greater than 500 volts, the common mode rating of the instrument will be exceeded. To eliminate this possibility during this particular high voltage measurement, the COMMON input to the instrument should be grounded.

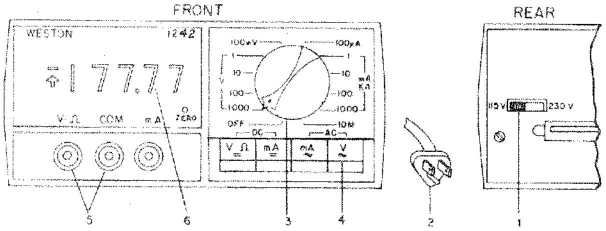


Figure 9. DC Voltage Measurement.

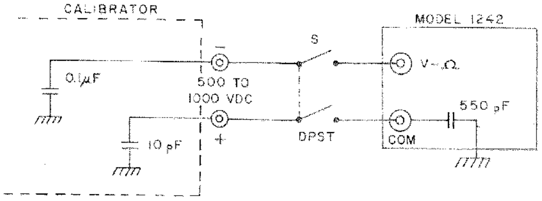


Figure 9A. High Common Mode Application Circuit

OHMS MEASUREMENT

1. Set LINE VOLTAGE SELECTOR switch, on rear panel, to proper line voltage position, and check that jumper plug is on rear card-edge connector.
2. Plug instrument power cord into AC power outlet.
3. Set RANGE switch to 100mV.
4. Depress FUNCTION push button DC (V–Ω) to DOWN position.
5. Connect test leads to input jacks marked V–Ω and COM. Allow 15 minutes warm-up for stabilization to insure best accuracy.
6. Short test leads. Display should read zero (00.00). If not, rotate ZERO control to achieve this.
7. Connect test leads to unknown resistance and observe reading. Increase or decrease range setting until proper range is reached. Table 2 indicates proper readout limits for each range.

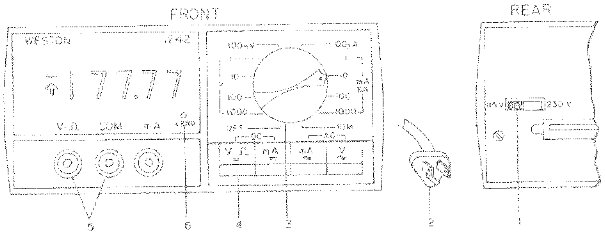


Figure 10. Ohms Measurement

TABLE 2. OHMS READOUT LIMITS

Range	Proper Readout Limits
1K	.0000 – 1.9999
10K	1.999 – 19.999
100K	19.99 – 199.99
1M	.1999 – 1.9999
10M	1.999 – 19.999

NOTE

When using the 1KΩ range, the reading with shorted input test leads may differ from that on other ohmic ranges. A small residue of less than one ohm may be indicated due to lead resistance. The user has the option of either subtracting this residue from his measurement of the unknown or nulling the lead resistance out by adjustment of the zero control. If the latter option is taken, the meter must be re-zeroed when returning to other ohmic ranges or modes of operation.

CAUTION (for 1K, 10K ranges)

The resistance measurement circuitry is protected up to 130 volts rms, 230 volts for 30 seconds, max. or DC against the application of excessive voltage, by the power dissipation of internal components. Application of higher voltages than this may damage the instrument. Short term errors may be noted in the resistance readings after overload, but accuracy will eventually recover to within specification.

DC CURRENT MEASUREMENT

1. Set LINE VOLTAGE SELECTOR switch, on rear panel, to proper line voltage position, and check that jumper plug is on rear card-edge connector.
2. Plug instrument power cord into AC power outlet.
3. Set RANGE switch to 1 ampere or desired lower range if known.
4. Depress FUNCTION push button DC—mA to DOWN position. Display should read zero. If not, rotate ZERO control to achieve this.
5. Using test leads, connect unknown DC current into input jacks mA and COM.
6. Observe reading: Decrease RANGE switch setting until proper range is reached. Table 3 indicates proper readout limits for each range.

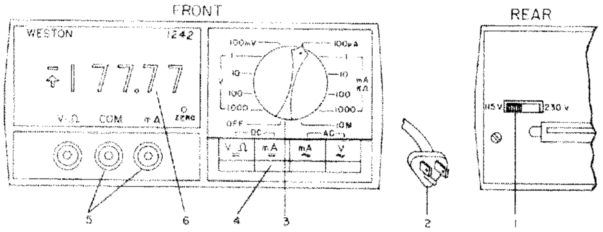


Figure 11. DC Current Measurement

TABLE 3. DC CURRENT READOUT LIMITS

Range	Proper Readout Limits
100 μA DC	00.00 – 199.99
1 mA DC	.1999 – 1.9999
10 mA DC	1.999 – 19.999
100 mA DC	19.99 – 199.99
1000 mA DC	.1999 – 1.9999

AC CURRENT MEASUREMENT

1. Set LINE VOLTAGE SELECTOR switch, on rear panel, to proper line voltage position, and check that jumper plug is on rear card-edge connector.
2. Plug instrument power cord in AC power outlet.
3. Set RANGE switch to 100mV.
4. Depress FUNCTION push button DC (V—Ω) to DOWN position.
5. Connect test leads to input jacks marked V—Ω and COM. Allow 15 minutes warm-up for stabilization to insure best accuracy.

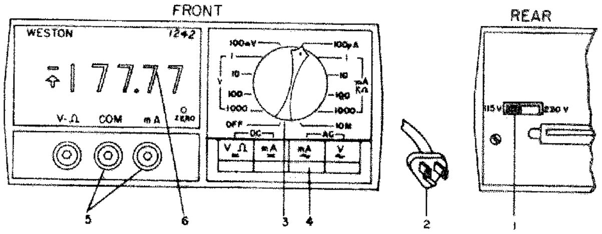


Figure 12. AC Current Measurement

6. Short test leads. Display should read zero (00.00). If not, rotate ZERO control to achieve this.
7. Set RANGE switch to 1000mA or to desired lower range if known.
8. Depress FUNCTION push button AC—mA to DOWN position.
9. Connect unknown AC current into input jacks mA and COM.
10. Observe reading: Decrease RANGE switch until proper range is reached. Table 4 indicates proper readout limits for each range.

TABLE 4. AC CURRENT READOUT LIMITS

Range	Proper Readout Limits
100 μA AC	00.00 – 199.99
1 mA AC	.1999 – 1.9999
10 mA AC	1.999 – 19.999
100 mA AC	19.99 – 199.99
1000 mA AC	.1999 – 1.9999

AC VOLTAGE MEASUREMENT

1. Set LINE VOLTAGE SELECTOR switch, on rear panel, to proper line voltage position.
2. Plug instrument power cord into AC power outlet.
3. Set RANGE switch to 100mV.
4. Depress FUNCTION push button DC (V–Ω) to DOWN position.
5. Connect test leads to input jacks marked V–Ω and COM. Allow 15 minutes warm-up for stabilization to insure best accuracy.
6. Short test leads. Display should read zero (00.00). If not, rotate ZERO control to achieve this.
7. Set RANGE switch to 1000V or the desired lower range if known.

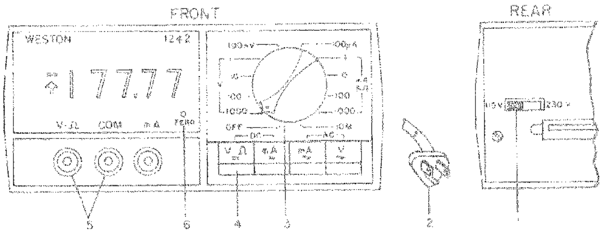


Figure 13. AC Voltage Measurement

CAUTION

500 volts is the maximum AC voltage allowable in the 1000V position.

8. Depress FUNCTION push button AC–V to DOWN position.
9. Observe readings. Decrease RANGE switch until proper range is reached. Table 5 indicates proper readout limit for each range.

TABLE 5. AC VOLTAGE READOUT LIMITS

Range	Proper Readout Limits
100 mV AC	00.00 – 199.99
1 V AC	.1999 – 1.9999
10 V AC	1.999 – 19.99
100 V AC	19.99 – 199.99
500 V AC*	1999 – 500.00

*This range is limited to 1/2 of nominal full scale because of breakdown considerations.

NOTE

When measuring AC voltage or currents, distorted sine waves can be a source of error. This instrument will indicate within rated accuracy only on pure sine waves. Typical 3rd harmonic distortion levels can introduce errors as much as 1/3 of the percentage of 3rd harmonic distortion present.

THEORY OF OPERATION

INTRODUCTION

This section presents the design and operating principles of the Digital Multimeter. The theory of operation is presented at the functional level in the paragraph immediately below and in greater detail on the pages following. Complete schematic diagrams are included for reference in the Drawings and Parts List Section.

The instrument incorporates all circuitry needed to make measurements of DC voltage and current, AC voltage and current, and resistance.

The basic measuring circuit is a bipolar analog to digital converter operating on the dual-slope principle. It has a measurement range of ±4 volts DC. All inputs are converted to DC volts and amplified or attenuated for measurement by this circuit.

Resistance is measured by passing a scaled constant current through the unknown and measuring the DC voltage across it. Maximum current never exceeds 100μA.

Alternating voltages are converted to DC by an average sensing, RMS calibrated converter assembly. Full scale output voltage for all ranges is 1 volt DC.

Current is measured by the voltage drop it establishes across a ring shunt network. If DC, it is measured directly. If AC, it is applied to the AC converter first. Full scale shunt voltage is 100 millivolts for all ranges.

The DC voltmeter section and the several conversion circuits are interconnected by a complex of function switches and rotary range switches which make possible decimal point switching, input ranging, gain changes in the preamplifier and shared usage of the precision attenuator. Rather than present the complete system diagram in the text, with all of its switching complexity, we have elected to present the functional modes, one sub-circuit at a time, indicating the required signal interfaces. Interconnection information is presented in the schematic diagrams in the Drawings and Parts List section and the interested user will be better equipped to follow it after first digesting the operating theory of the functional parts.

We have started with the A/D converter, that circuit being basic to all other modes. Then the front-end analog circuitry including attenuator, amplification and switching which complete the DC voltmeter circuit. Resistance, current, AC converter, and power supply follow in that order.

The following sections will present the theory of operation of the A/D converter.

CIRCUIT DESCRIPTION

DC VOLTMETER CIRCUIT

Common to all measuring functions is a dual slope, bipolar A/D converter. The operating voltage is ±4 volts full scale for 10,000 digits with a 100% overrange capability. All measurands are scaled to ±4 volts by a preamplifier and suitable attenuators, shunts, or converters. The display has a maximum reading of 19999 suitable accompanied by decimal points, polarity sign and an outrange display.

The circuit operation will be explained with the aid of Waveforms Figure 14 and the Block Diagram Figure 15.

DUAL-SLOPE A/D CONVERSION

Dual-slope is an integrating method of A/D conversion which, in common with all integrating methods, reduces the affect of power-frequency interference on the input or appearing as power supply ripple. Integrating time is 100 MS, providing excellent rejection of 50Hz, 60Hz, 400Hz and any other components whose periods are integral sub-multiples of 100MS.

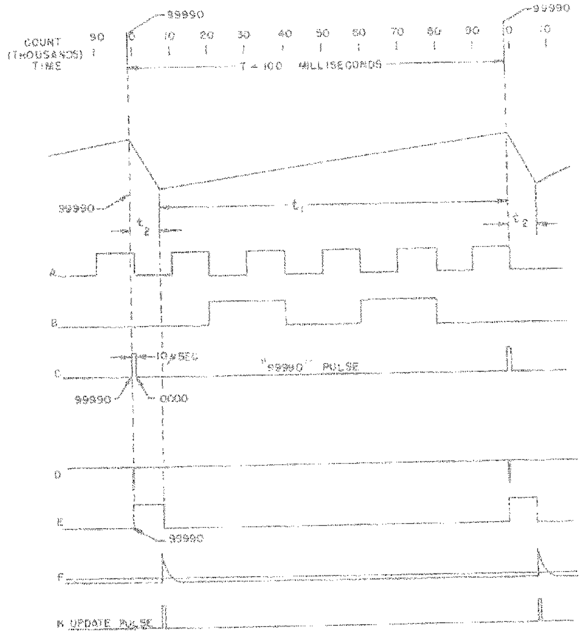


Figure 14. A/D Converter Waveforms

The dual-slope feature provides an added, unique advantage, not common to other integrating methods. In older systems, amplitude is converted into a time interval, which is digitized by counting the number of clock pulses in that interval. Conversion accuracy is directly dependent on clock accuracy, on the stability of an RC timing network, and of a voltage reference. Dual-slope, by contrast, converts amplitude into a ratio of two time intervals, both proportional to clock period and hence independent of clock accuracy. Only a stable voltage or current reference and stable resistor, both easily attainable, are required.

Figure 14 shows the integrator waveform responsible for this conversion. Integrating cycle time is constant at 100 milliseconds, corresponding to 100,000 pulses from the 1MHz clock oscillator. The cycle is divided into two intervals; ramp up t_1, and ramp down t_2. The waveform shown corresponds to a negative DC input, for which the integrator will ramp in the positive direction. Positive inputs create a negative ramp.

During t_1, the integrator ramps up from zero under the influence of Ein, R, and C such that

$$E\,\text{max} = \frac{\text{Ein}}{R} \times \frac{t_1}{C}\ \text{volts}$$

Interval t_1 is terminated when the counter state reaches 99990, at which point I_{REF} is injected. The sense of I_{REF} is opposite to that of Ein and its magnitude is always larger than Ein/R so that the integrator now discharges at a rate

$$\frac{1}{C}\left(I_{REF} - \frac{\text{Ein}}{R}\right)\ \text{volts/sec}$$

Interval t_2 will terminate at zero crossing such that

$$\frac{\text{Ein}\, t_1}{RC} = \frac{(I_{REF} - \text{Ein})}{R}\;\frac{t_2}{C}$$

Since $t_1 + t_2 = T$, solving for t_2 yields $t_2 = \dfrac{\text{EinT}}{I_{REF}\;R}$

Further, since T contains 100,000 pulses, we can express t_2 and T in terms of numbers of pulses, as

$$N = \frac{100{,}000\ \text{Ein}}{I_{REF}\;R}$$

Therefore N is a quantity which is independent of both clock frequency and capacity C. If interval t_2 were to start at 100,000 (equivalent to zero) instead of 99990, the transfer command generated at the end of t_2 would then transfer the number N into display storage, presenting a readout proportional to Ein. For reasons to be detailed later, the start of t_2 is advanced 10 clock pulses and an offset voltage equivalent to 10 microseconds is injected so that in the absence of Ein the display will read zero.

The conversion process repeats with a new conversion every 100 milliseconds. If the new count is the same as the previous one, the number in storage will not change, and no flicker will result.

The points to remember in reading what follows is that the key events in each cycle are the count 99990 which initiates t_2 by introducing a reference current, and the crossing of zero by the integrator, which terminates t_2 and commands a readout into storage.

For reference purposes, the full scale input voltage to the integrator is ±4 volts, and input resistor R is 40 Kilohms, providing a full scale input current of 100 microamperes (for 10,000 digits). the sensitivity of the converter is thus 400 microvolts/digit or 10 nanoamperes/digit.

A/D CONVERTER — DETAILED CIRCUIT DESCRIPTION (Figure 15)

The analog to digital converter and the 20,000 bit display it generates is under the control of a 100,000 bit timing sequence, driven by a 1MHz clock oscillator. The 1MHz clock drives a 100,000 bit counter chain consisting of five decade counters U207 through U211. Counters U208, U209, U210 and U211 accumulate counts up to 9999 and drive two 8 bit storage registers U205 and U206. Counter U207 accumulates the 10,000 count and provides outrange sensing and control functions. Waveforms derived from U207 are shown at A,B, and C of Figure 14.

Synchronization

Interval t_2 is synchronized by pulse waveform C, a 10μsec wide pulse (also referred to as the 99990 pulse) which occurs only once in each 100,000 clock pulses. Its leading edge is shaped by an RC network and inverter 106E to provide a negative pulse D, setting the Reference Enable Latch 105B. The Reference Enable Latch occupies a central position in the operation of the converter. When set, producing a positive transition at E, it permits a reference current to be injected into the integrator, starting interval t_2.

Polarity Sensing

Simultaneously, the positive transition of C triggers polarity sensing Flip-flop U212A, causing it to take a state determined by the polarity of the input signal at that time. Polarity is determined by the state of comparator U103, as transmitted by 106F and 107A. For the present example, a negative input causes a positive ramp. Therefore, at the onset of t_2, the ramp is at its greatest positive value, and the sense line is low since U103, 106F, and 107A invert. Consequently U212A is set to zero. When this state is transferred to U212B at the end of t_2, the "—" lamp is enabled.

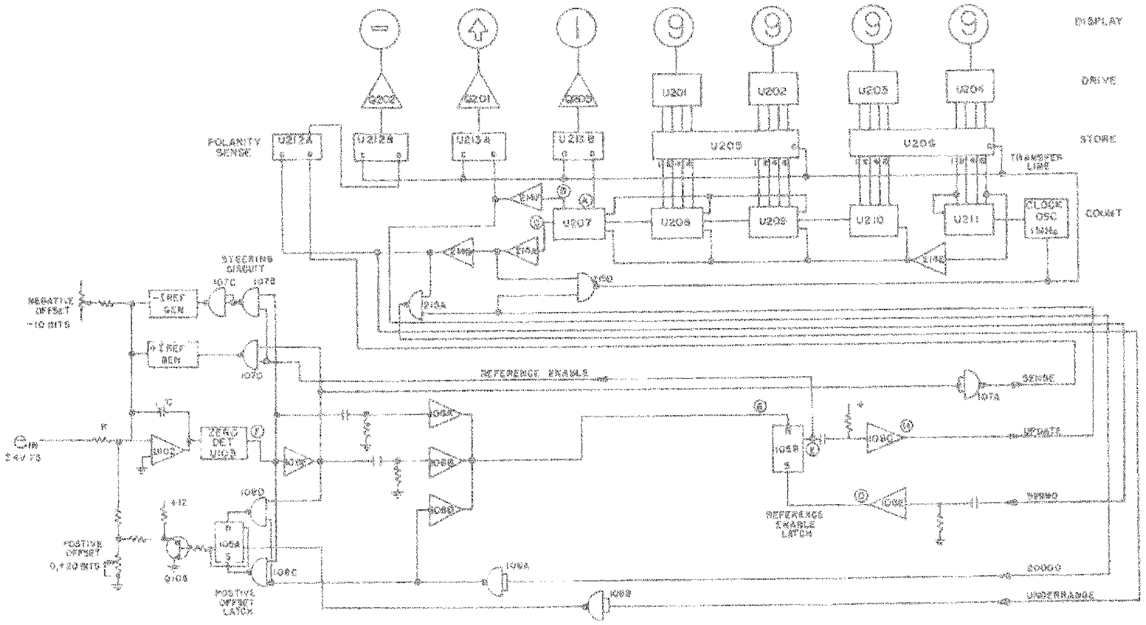


Figure 15. Block Diagram

Reference Current Control

During t_2, the "1" state of the Reference Enable Latch (105B) enables gates 107B and 107D, permitting one of the reference current generators to inject 1 mA into the summing junction. The choice of reference current polarity is made by logic gates 107B, C, and D under control of the steering inputs provided by comparator U103 and inverter 106F. Since input signal polarity is negative in this example, a positive current is injected into the summing junction of U102 forcing the integrator back to zero.

Zero Crossing

Interval t_2 ends when the integrator output reaches zero. In so doing, the output of zero-detector U103 undergoes an abrupt positive transition, (F). The resulting waveform is shaped into a negative trigger pulse at (G). (If the input voltage had been positive, a negative transition at F would have been similarly shaped after inversion by 106F. Therefore, any zero crossing is converted into a negative trigger pulse.) The trigger pulse is applied to reset Reference Enable Latch 105B, resulting in a return of waveform E to level zero. This transition initiates several actions as noted below.

Readout Command

First the negative transition at E is shaped by an RC network and inverter 106C into a positive pulse 100 nsec wide, waveform H. This is inverted by 215D (unless inhibited under special conditions described below under OFFSET) and commands the storage registers U205 and U206, to accept new count information from the decade counters. The count transferred at this time will be the number N developed during t_2. Time is thus made available by the width of H for ripple-through of carries which may have started just prior to zero crossing. Also, during the storage command pulse, the clock oscillator is momentarily inhibited, preventing any new pulses from entering the counter. At the termination of the transfer pulse, the storage registers are locked up at their new condition and the display tubes they drive remain fixed in display.

The positive going trailing edge of the transfer pulse activates three more functions. It transfers the state of the waveform A (which goes high at the count of 10,000) into storage flip-flop U213B, and that of Waveform B (which goes high at 20,000) into the outrange storage flip-flop U213A. It also transfers polarity information from polarity-sensing latch U212A into polarity-storage flip-flop U212B.

Offset

It will be recalled that the start of t_2 is offset in time by 10 clock pulses to a count of 99990, and that an analog offset voltage equivalent to 10 digits (0.1% of full scale) must be introduced into the integrator to make the display read zero when Ein = 0. The reason for this offset and the mechanism by which it is accomplished will now be presented.

During t_1 and in the absence of any injected offset, the integrator would ramp up completely under control of Ein. If Ein were very small the slope would be correspondingly small. During t_2, the reference current reverses this slope sharply, crossing zero and driving the zero-crossing comparator to its opposite state. Ideally, the crossing of zero would immediately terminate the reference current and result in a reversal of the ramp and an immediate return of the comparator to its initial state. Practically, however, inevitable time delays and finite comparator gain, result in an overshoot during t_2. When the reference current is terminated, the small ramp slope due to small values of Ein could prevent the comparator from being immediately reset. In particular, if the slope were small enough, the comparator would not be reset before the next synch pulse (99990) occurs. In that event, the wrong reference current will be injected and an oscillatory mode of behavior will take place in which the display will alternate between excessively low and excessively high readings. To prevent this, an offset is permanently injected, so that even when Ein = 0, the ramp up slope will be large enough to permit comparator recovery during one 100 ms frame. Ten digits worth of offset are injected (100nA) and the logic is offset from zero to 99990 to compensate.

The polarity of the offset must be the same as the polarity of the input signal. To achieve this, two offset sources, one fixed and one digitally controlled, are provided. The first, a negative offset provides a net 10 bit negative input current to the summing junction of the integrator (including compensation for intrinsic offset in the integrator operational amplifier). The second is a 20 digit positive offset which can be switched on or off. The two provide a choice between +10 (+20−10) and −10 (0−10) digits.

The +20 digit offset is under control of switch Q108 and offset latch U105A, and operates as follows. At the digital count of 20,000 (chosen for convenience), gates 108C and 108D are enabled and the state of the zero comparator is used to steer a set or reset pulse to latch 105A. If input Ein is positive, this will be reflected in the state of the comparator and the latch set so that Q108 is turned off and the +20 digit offset is turned on. For negative inputs the reverse is true. When Ein is large, there is no ambiguity or oscillatory behavior.

If Ein were to drop from some large positive value to some small negative value (e.g. −5 digits), then the count available at zero crossing would be 99995, rather than −5. Logic has been provided to inhibit transfer of count into storage under this condition. Waveform C will be high during "99990−100,000", the output of 214A will be low, and the update pulse will be inhibited from passing through U215D. Further, the presence of an update pulse from 106C during the interval (99990 to 100,000) will create an UNDERRANGE pulse (positive) at 215A which will be fed back to latch 105A, toggling it to its opposite state. The offset current will then reverse and the signal and offset will again be of the same polarity. Only one conversion period is lost during the changeover and the affect is not disturbing.

For further details of the logic and conversion circuitry, refer to the schematic diagrams at the rear of this manual.

DC VOLTMETER–ANALOG SECTION

The previous section described the operation of the A/D converter, with emphasis on the logic. This section will describe the analog circuitry, including the integrator and current sources, the preamplifier, and the various front-end converter circuits. For greater detail and specific component values, refer to Figure 25, Analog Schematic Diagram.

Integrator

The basic integrator circuit, Figure 16, consists of an operational amplifier, connected in the inverting mode, and the logic-controlled current sources necessary for controlling ramp action, as described in the previous section.

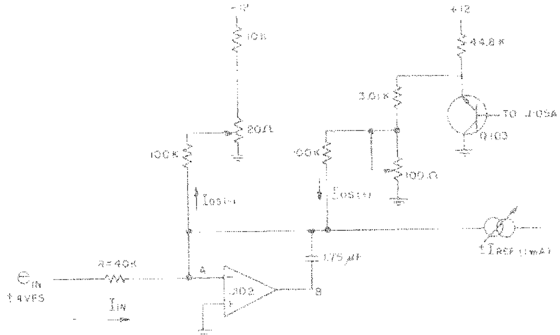


Figure 16. Integrator Circuit

Since the amplifier summing junction A is a virtual ground $I_{in} = (4V/40K\Omega) = 100\mu A$ full scale. During interval t_1, with no reference current, a negative 4 volt signal will draw $100\mu A$ from the $1.75\mu F$ capacitor forcing the integrator output B to ramp upwards linearly to support this current. When, at the count of 99990, a reference current of + 1mA is injected into the summing junction, the reference will supply the $100\mu A$ and the remaining $900\mu A$ will discharge the capacitor. B will then fall back towards zero at a rate 9 times as great as its rise and will take 10,000 clock pulses to reach zero. Other input voltages will give rise to corresponding fall times and displays. For example, an 8 volt input to the integrator would cause $200\mu A$ to flow through R. A four-to-one time ratio would occur and the display count would be 20,000.

Integrator Offset Adjustment

Neglecting, for the moment, the 10 bit offset needed to insure stable readings near zero, there remains an inherent offset in the integrating amplifier, U102, which can account for up to±5 digits of error. This must be zeroed out to prevent unpredictable ramping in the absence of a signal input. In addition, a switchable offset of ±10 counts must be provided for zero region stability. The negative offset supply shown in Figure 16, provides a permanent offset of −10 digits beyond that needed for the ±5 inherent in the amplifier. It does this by possessing a range of from −5 to −15, with some margin to spare for component tolerances.

The positive offset supply is set for +20 digits under logic control which can change it from +20 to zero. The net offset will thus be either +10 (+20 −10) or −10 (−10 +0). Since the injected offset is only 10 digits, an inaccuracy or drift of this value by one or two percent will be inconsequential and these circuits are therefore not regulated beyond that which the power supply provides.

Reference Current Circuit

The reference current circuit consists of a stable 6.2 volt reference, a low offset transistor switch and stable scaling resistors, and is illustrated in Figure 17 for the case of a positive reference (used with negative inputs).

Q106 is the series switch, operated in the reverse alpha mode. Q107 is the control transistor which permits Q106 to close when point A goes to zero. Under this condition, the Q106 is biased on and the 6.2 volts appears (with negligible transistor drop) at the emitter. Since the summing junction is a virtual ground, the current which flows is determined by V_{REF} and the total resistance, which can be adjusted for full scale calibration. In order to achieve settability to one part in 20,000 during calibration, the resolution of the resistance network would have to be 0.005% of 6200 ohms or about 0.3 ohms. Practically achievable pot resolutions place the pot requirement at 50 ohms. However, a span of 50 ohms in 6.2K is less than 1% making it impossible to accommodate economically achievable zener diode tolerances. A selectable Resistor R136 provides a coarse trim to span a 3% tolerance range for the diode. It is a customized 5 terminal network with jumper leads and is programmed during calibration in 37 ohm increments.

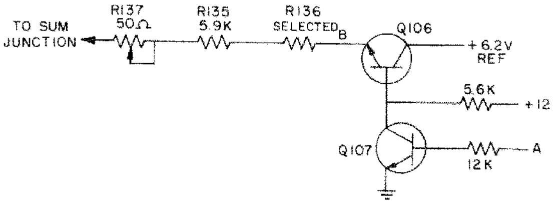


Figure 17. Reference Current Circuit

Voltmeter Input Circuit

It has been pointed out that the integrator operates at ±4 volts full scale. This level which amounts to 400 microvolts per digit renders the A/D converter relatively insensitive to offset voltage variations (due to time and temperature) in the integrator. To achieve this level on all input ranges, requires both attenuation and gain. These two functions are shown in Figure 18.

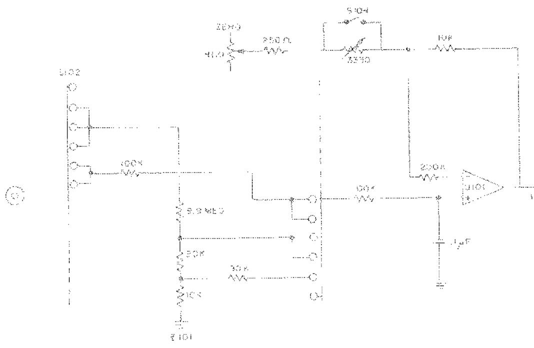


Figure 18. Voltmeter Input Circuit

U101 is a non-inverting amplifier with a gain of either 4 or 40. The non-inverting connection guarantees very high input impedance so that attenuator Z101 is not affected by loading changes as the range is change. The input circuitry of U101 is designed to provide very low input bias currents (2nA max.) and very low offset voltage drifts with temperature (2µV/°C max.). These low values are essential to the stability of the instrument.

On the 100mV and 1V ranges, the input is applied directly through two 100K buffering resistors which both guarantees a minimum balancing source resistance of 200K and absorbs energy due to overloads. the 10V, 100V, and 1000V ranges use a 10 megohm thin film attenuator with taps at 1/100 and 1/1000. The attenuator is padded to maintain a uniform 200K source resistance for the amplifier regardless of range settings, this balance being essential to minimize zero shifts with temperature, and range change.

This combination of attenuator and switch design, needed to maintain uniform source resistance, causes the amplifier U101 to alternately see 100mV or 1V full scale, (100mV on the 100 mV and 10V range, 1 volt F.S. on the remainder). Therefore, the gain must be switch by 10 to 1 when changing ranges to maintain 4V F.S. out. Gain switching is accomplished by S104, and the two gains are adjusted for an exact 10 to 1 ratio by an internal resistor adjustment (R114, R115, R117).

Finally, an input capacitor is provided for input overload protection and supplementary input filtering.

OHMS CONVERSION

Resistance is converted to a DC voltage by means of a current source according to Table 6. The currents are scaled to produce full scale voltages of +100mV on the 1KΩ range and +1 volt on all other ranges.

TABLE 6. OHMS CONVERSION

Range	I_s	R scale	E F.S.
1K	100µA	10K	100mV
10K	100µA	10K	1V
100K	10µA	100K	1V
1MΩ	1µA	1MΩ	1V
10MΩ	100nA	10MΩ	1V

It will be noted that a voltage of 1 volt is maintained across the scaling resistor (I_s x R scale) on all ranges. This is accomplished by a boot-strapping technique as shown in Figure 19.

The voltage developed across Rx, E(Rx), is applied to the voltmeter input. Because both inputs of U191 are forced by feedback to assume the same potential, E(Rx) is also applied to the positive input of U104. A 1mA current source applied to the negative input of U104 acts through R150 to add an additional 1 volt to E(Rx) at the output. Since the scaling resistor (R149 or part of Z101) is connected between U104 output and the V—Ω input terminal, the voltage across it will be maintained at 1 volt.

The current through Rs is then determined only by Rs as shown in Table 6. Assuming that negligible current is drawn by amplifier U101 (a practical assumption for most ranges), then the constant current will all flow through Rx creating the voltage to be measured.

Special design considerations which exist at the lower and higher ranges are as follows:

1. 1K,10K range — These ranges require 10K for a scaling resistor. While the 10K could have been derived from a section of Z101 rather than as a separate component, the result would have been extreme vulnerability to burn out by misapplication of high voltage when in the 1K or 10K range position. Therefore, a precision power resistor is employed for these ranges.
2. 10MΩ range — On this range, the current source is 100nA. Amplifier U101 can draw up to 2nA. Therefore, a 2% error can exist unless compensated. The 10MΩ scaling resistor is reduced by tapping Z101 at 9MΩ and adding an adjustable resistor (R147 and R148).
3. 1MΩ range — This range, operating on a 1μA current source is susceptible to 2n bias current affects to the extent of 0.2%. This small error did not warrant a compensation control, but the scaling resistor tap on Z101 is reduced from 1MΩ to 999K to allow for an average value of bias current.

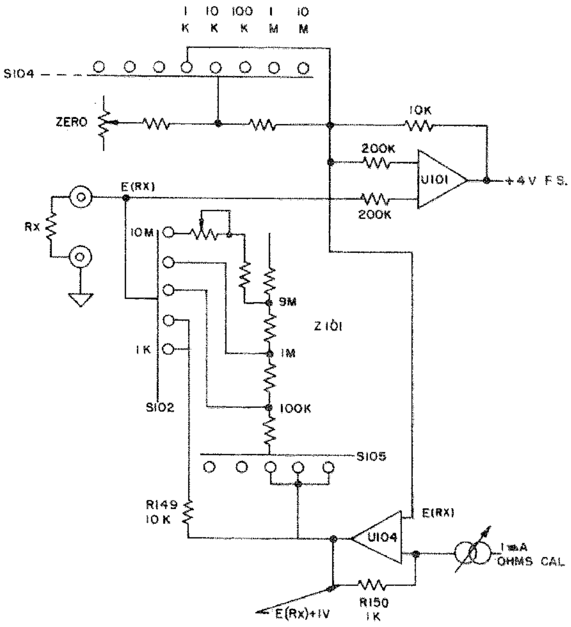


Figure 19. Ohms Conversion Circuit

DC CURRENT CONVERSION

DC current is converted to a DC voltage by the network shown in Figure 20. Five 0.1% wirewound resistors are arranged in series, with taps, selectable by the range switch, at 0.1, 1, 10, 100, and 1000 ohms. The remaining circuitry is provided for overload protection only.

Current applied between the mA and COM jacks flows through the selected portion of the shunt network, developing a voltage between the selected tap and circuit ground. Since the total shunt resistance increases in decade steps as current range decreases, the full scale shunt voltage remains fixed at 100 millivolts for all ranges.

Accuracy is maintained on the highest current range by using a four-terminal Kelvin connection for the 0.1 ohm resistor. Thus, currents of up to 2 amperes are kept out of the potential circuit and cannot create added voltage drops in the intervening leads to appear as measurement errors.

The shunts are protected from damage due to excessive current by a combination of diode-clamps and fuse. The clamp circuit consists of two pairs of diodes, one for each polarity of overload. The S5A05 is a general purpose power diode permanently biased into conduction so as to back bias the low leakage S1594. Since the voltage, even at 100% overrange, is 200 millivolts, the upper diode will normally be back-biased between 400 and 800 millivolts, a level sufficient to prevent excessive leakage, even for the 100μA range. If a constant current sufficient to generate more than 1.2 volts is applied, the diodes will conduct and divert any larger currents away from the shunt resistors.

If the current should rise beyond 3 amperes, due to an excessive current source, or due to application of full line voltage, the fast response 3 amp fuse will blow and both shunts and diodes will be protected. The diodes have sufficiently high surge rating to withstand the momentary current pulse generated until the fuse disconnects.

All that has been said of DC current conversion applies equally to AC current conversion, except the routing of shunt voltage. In the case of AC currents, a voltage waveform of 100mV RMS full scale is generated in the potential circuit. This waveform is converted to a DC voltage of 1 volt full scale by the AC Converter assembly. Interface between the shunt network and the operational rectifier in the AC Converter assembly is discussed more fully in the next paragraph.

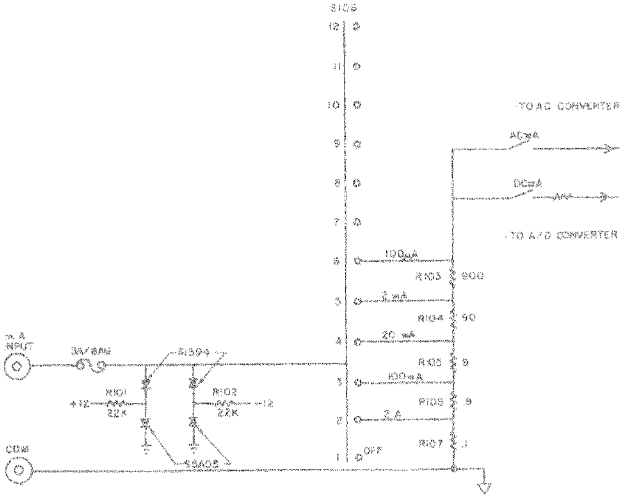


Figure 20. DC Current Converter Circuit

AC CONVERSION

The measurement of alternating voltages, whether due to AC voltage sources or current sources converted to voltage by shunts, is accomplished by an average sensing, RMS calibrated operational rectifier, supported by circuit elements which control ranging, frequency response adjustment and output ripple filtering. The circuit elements are shown in simplified form in Figure 21. Tracing signal flow from input leads through to the A/D converter, the following circuit functions are encountered:

1. Input Switches – These are push button switches which couple the AC converter to either the V–Ω input jack or the shunt chain depending on the measuring function. The ACV switch also protects the AC input coupling capacitor from high DC voltages which might be applied in the DCV mode.
2. Input Capacitor – Blocks DC components riding on the input which might otherwise bias the buffer out of its proper operating range.
3. Input Attenuator – A 1 megohm resistor string with taps at 1/100 and 1/1000. Signal levels of 100mV or 1V full scale bypass the input attenuator and are applied directly to the buffering circuit which drives the operational rectifier. Larger signals are attenuated to one of these two levels by action of S401.
4. Following the attenuator is a clamp network formed by two low-leakage, low capacitance diodes. The diodes protect the buffer and series resistors protect the diodes, in case destructive voltage levels are inadvertently applied.
5. A FET/bipolar follower circuit provides high input impedance and low output impedance at approximately unity gain.
6. Following the buffer, is the input network of the operational rectifier. Voltages of 100mV or 1V full scale are converted into input currents of 10 microamperes F.S. RMS.

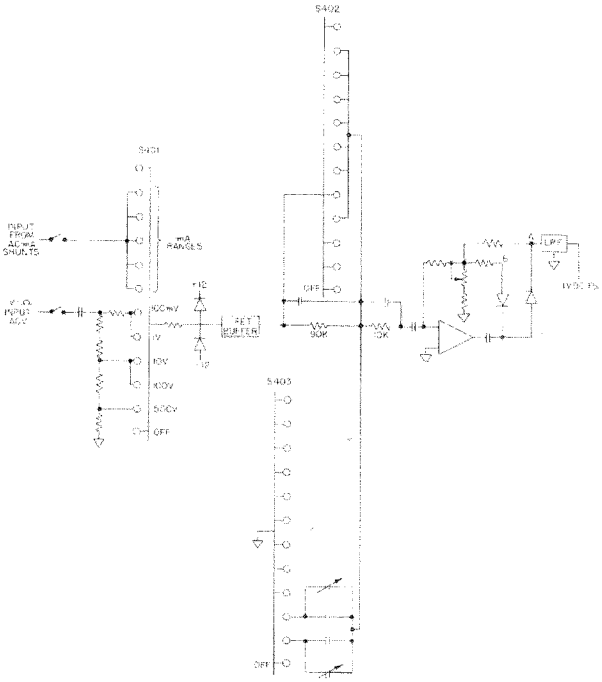


Figure 21. AC Converter Circuit

The input network switches in value from 10K to 100K under control of S402 to maintain the 10 microampere full scale level under all ranges.
Two capacitors are provided in shunt with the 90K and 10K input resistors to peak-compensate for roll-off introduced by stray capacity at the input of the buffer. In addition, two switchable roll-off networks, from the resistor junction to ground are provided to compensate for the inevitable peaking which is due to stray feed-forward which is most objectionable on the two highest voltage ranges.

7. The operational rectifier provides sharp half-wave rectification and gain. Input negative half-cycles produce a positive half-wave rectified sine wave at A. The feedback ratio is adjusted to provide a peak output voltage of 3.14 volts for a 10 microampere RMS input signal.

8. Subsequent RC filtering leaves only the DC Component. The RC network is multi-pole to minimize ripple content without introducing excessive response time delays. The source impedance seen by the DC preamplifier looking back into the LP filter is 100K, so as to maintain the source impedance balance required for good zero-stability.

When AC current is being measured, the shunt network on the mother board converts it to 100mV full scale and presents it to the converter through S401. Since all current ranges present 100mV full scale, the 90K resistor in the rectifier input network remains shorted for all ranges.

POWER SUPPLY

The power supply circuit provides a regulated ±12 volt source for the analog and reference circuitry, and a regulated 5 volt source for the digital circuits. In addition, a halfwave rectifier supplies an unfiltered high voltage supply for the numeral display tubes and neon indicators.

Low TC reference zeners are included as part of the power supply, and serve both to regulate the supply and as a reference source for the A/D converter. Current loads on the ±12 volt supply are balanced to maintain the reference diode operating points at the point of minimum T.C.

Regulation with respect to line is adequate for operation over +15% to −10% line voltage variations.
Two nominal line voltage levels of 115 volts and 230 volts have been accommodated by a rear panel switch changing the primary winding connections from parallel to series-aiding.

MAINTENANCE

In the course of normal operation, the instrument should require no maintenance other than the occasional replacement of indicator lamps or overload protection fuse. Faulty operation may often be traced to improper settings of controls. A brief list of potential symptoms and suggested remedies is in order.

1. Power Fuse blown out – check setting of 115V/230V switch on rear panel. If line voltage is 230 volts, the switch should be set accordingly.
2. Half-bright or ill-defined display – rear panel switch may be set to 230 volts on a 115VAC line.
3. Dim or partially defined digits on one or more indicator tubes – normal wear condition of numeral glow tube. Numeral tubes may be replaced after removing the window, a flexible panel which will be removed and reinserted by curving it about a horizontal axis.
4. Dim neon bulb indicators ("–", 1, ↑) – this is a normal wear condition. Neon indicator may be easily unsoldered for replacement since they are assembled with eyelets. See Installation Panel Mounting for instructions on Front Removal.
5. Runaway display – this is indicative of an open in the input circuit to the A/D converter. Either all push-buttons are up, or the situation is a normal result of operating on the two lowest AC or DC voltage ranges. If the test leads are not terminated in a return path, the display will escalate uncontrollably. Check the circuit being measured for continuity.

TEST EQUIPMENT REQUIRED

Table 7 lists the test equipment required for checking performance or calibration. It is important to use instruments of adequate accuracy and with a recalibration period sufficient to assure confidence in the results.

TABLE 7. TEST EQUIPMENT

EQUIPMENT	PURPOSE	REQUIRED SPECIFICATION
DC Voltage Standard	DC Voltage Calibration	Accuracy: ± 0.003% rdg Range: 1mV to 1000V
DC Current Standard	DC Current Calibration	Accuracy: ±0.02% rdg Range: 10μA to 1A
AC Voltage Standard	AC Voltage Calibration	Accuracy: ±0.05% rdg Range: 10mV to 500V 40Hz to 20KHz
AC Current Standard	AC Current Calibration	Accuracy: ±0.1% rdg Range: 10μA to 1A 40Hz to 10KHz
Resistance Standard	Resistance Calibration	Accuracy: ±0.02% rdg Range: 100Ω to 10MΩ

PERFORMANCE CHECK

To verify the specifications of the instrument, the following performance check is recommended.

Where reference standards are required, it is important to use units of adequate accuracy and with a recalibration period sufficient to assure confidence in the results.

DC VOLTAGE ACCURACY CHECK

1. Set line voltage selector switch on rear of panel for 115 or 230 volt operation as required, and install jumper plug on card-edge connector.
2. Connect power cord to instrument and AC power source.
3. Set range switch to 10 volt position.
4. Depress function push button DC (V–Ω) to down position.

5. Insert test leads in jacks V–Ω and COM. Allow approximately 60 minutes warm up to assure best results.
6. With test leads shorted, adjust zero control on front until display reads 0.000.
7. Set output of DC voltage standard to zero. Connect V–Ω and COM leads on instrument to (+) and (–) output terminals respectively on voltage standard.
8. Referring to Table 8, set voltage standard to output levels tabulated. Set range switch to its appropriate setting on instrument. Check to insure that readout falls within limits specified, if not refer to appropriate calibration procedure.

TABLE 8. DC VOLTAGE ACCURACY AT REFERENCE CONDITIONS

Voltage Input	Range Switch Setting	Readout Limits	
		Min.	Max.
Input Shorted	100mV	00.00	±00.02
±1.0mV		±00.00	±01.01
±10mV		± 9.98	±10.02
±100mV		±99.93	±100.07
Input Shorted	1V	0.000	±0.001
±1V		±0.9994	±1.0006
±10V	10V	±9.994	±10.006
±100V	100V	±99.94	±100.06
±1000V	1000V	±999.4	±1000.6

RESISTANCE ACCURACY CHECK

1. Set line voltage selector switch on rear of panel for 115 or 230 volt AC line operation as required, and install jumper plug on card-edge connector.
2. Connect power cord to instrument and AC power source.
3. Depress function push button DC (V–Ω) to down position.
4. Set range switch to 100mV range.
5. Insert test leads in jacks V–Ω and COM. Allow approximately 60 minutes warm up to achieve best results before testing.
6. With test leads shorted, adjust zero control on front until display reads 00.00. The meter is now ready for resistance measurement.

NOTE

When checking the 1KΩ range for accuracy, it will be necessary to rezero the meter to compensate for test lead resistance.

7. Connect meter to resistance standard.
8. Referring to Table 9, set resistance standard to values listed. Set range switch to proper range. Check to insure readout is within limits given, if not refer to calibration procedure.

TABLE 9. RESISTANCE ACCURACY AT REFERENCE CONDITIONS

Resistance Standard	Range Switch Setting	Readout Limits	
		Min.	Max.
Input Shorted 1KΩ	1KΩ	.0000 .9984	±.0001 1.0016
10KΩ	10KΩ	9.989	10.011
100KΩ	100KΩ	99.89	100.11
1MΩ	1MΩ	.9974	1.0026
10MΩ	10MΩ	9.949	10.051

DC CURRENT ACCURACY CHECK

1. Set line voltage selector switch on rear of panel for 115 or 230 volt line operation, as required, and install jumper plug on card-edge connector.
2. Connect power cord to instrument and AC power source.
3. Set range switch to 100mV range.
4. Depress function push button DC V–Ω.
5. Insert test leads in mA and COM jacks. Allow approximately 60 minutes warm up to achieve best results before testing.
6. With no leads attached, adjust zero control for a reading of 00.00. The instrument is now ready for current testing.
7. Set output of DC current standard to zero. Connect mA and COM leads on instrument to (+) and (–) output terminals respectively on current standard.
8. Referring to Table 10 set current standard to values listed. Set range switch to proper range. Check to insure readout is within limits given.

TABLE 10. DC CURRENT ACCURACY AT REFERENCE CONDITIONS

DC Current Input	Range Switch Setting	Readout Limits	
		Min.	Max.
0 ±100.00µA	100µA	00.00 ±99.84	±00.01 ±100.16
±1.0000mA	1mA	±.9984	±1.0016
±10.000mA	10mA	±9.840	±10.016
±100.00mA	100mA	±99.84	±100.16
±1000.0mA	1000mA	±998.4	±1002.1

AC VOLTAGE ACCURACY CHECK

1. Set line voltage selector switch on rear of panel for 115 or 230 volt AC line operation as required, and install jumper plug on card-edge connector.
2. Connect power cord to instrument and AC power source.
3. Set range switch to 100mV position.
4. Depress function push button DC V–Ω to down position.
5. Insert test leads in V–Ω and COM jacks. Allow approximately 60 minutes warm up to obtain best results.

6. Short input leads and adjust zero control for a reading of 00.00. The instrument is now ready for AC volts testing.
7. Set AC voltage standard to zero. Connect V–Ω and COM leads on instrument to output terminals on AC voltage standard. Depress AC–V switch.
8. Referring to Table 11 set voltage standard to output levels tabulated. To fully check AC voltage, performance tests at tabulated levels should be made at frequencies of 40Hz, 60Hz, 400Hz, 10KHz and 20KHz. Set range switch on instrument to its appropriate setting. Check to insure that readout falls within limits specified.

AC CURRENT ACCURACY CHECK

1. Set line voltage selector switch on rear of panel for 115 or 230 volt AC line operation as required, and install jumper plug on the card-edge connector.
2. Connect power cord to instrument and AC power source.
3. Set range switch to 100mV position.

TABLE 11. AC VOLTAGE ACCURACY AT REFERENCE CONDITIONS

AC Voltage Input	Range Switch Setting	Readout Limits					
		40Hz		60Hz to 10KHz		20KHz	
		Min.	Max.	Min.	Max.	Min.	Max.
00.00	100mV	00.00	00.05	00.00	00.05	00.00	00.05
100.00mV		99.70	100.30	99.75	100.25	99.45	100.55
.10000V	1V	.0992	.1008	.0993	.1007	.0990	.1010
1.0000V		.9970	1.0030	.9975	1.0025	.9945	1.0055
1.000V	10V	.992	1.008	.993	1.007	.0990	1.010
10.000V		9.970	10.030	9.975	10.025	9.945	10.055
10.00V	100V	9.92	10.08	9.93	10.07	9.90	10.10
100.00V		99.70	100.30	99.75	100.25	99.45	100.55
500.0V	500V	499.3	500.7	498.5	501.5	497.0	503.0

4. Depress function push button DC V–Ω to down position.
5. Insert test leads in V–Ω and COM jacks. Allow approximately 60 minutes warm up to obtain best results.
6. Short input leads and adjust zero control for a reading of 00.00. The instrument is now ready for AC current testing.
7. Set AC current standard to zero. Connect mA and COM leads on instrument to output terminals of current standard.
8. Referring to Table 12 set current standard to output levels tabulated. To fully check AC current, performance tests at tabulated levels should be made at frequencies of 40Hz, 60Hz, 400Hz and 10KHz. Set range switch on instrument to its appropriate setting. Check to insure that readout falls within limits specified.

TABLE 12. AC CURRENT ACCURACY AT REFERENCE CONDITIONS

AC Current Input	Range Switch Setting	Readout Limits 40Hz to 10KHz	
		Min.	Max.
00.00μA 100.0μA	100μA	00.00 99.60	00.05 100.40
1.0000mA	1mA	.9960	1.0040
10.000mA	10mA	9.960	10.040
100.00mA	100mA	99.60	100.40
1000.0mA	1000mA	995.5	1004.5

CALIBRATION

If any of the performance checks fail, a recalibration may be required. Meter should be warmed up 60 minutes before calibrating. The starting point of any recalibration is the setting of zero. This should be done on the 10V DC range with the input leads shorted.

NOTE

Linking terminals is preferable, if possible.

1. R110 should be adjusted for a reading of –00.00, and then backed off until the "–" sign extinguishes. This procedure will be adequate for all routine zero adjustment. Zero readings on all other DC voltage ranges and on all DCmA ranges should be within 1 digit of zero. If not, due to internal drifts with time, a more critical adjustment of zero can be made as follows.
2. With the input leads shorted and the DC V–Ω button depressed, switch back and forth between 100mV and 1 volt range positions, adjusting R110 until the reading is the same for both positions, even though that reading may not be zero.
3. Set the range switch to the 100mV position and apply –200 microvolts. Adjust R124 to read –20 counts. Switch the input signal to +200 microvolts. The display should read 20. (If it does not read 20 within ±1 count, an internal adjustment may be required, to insure maximum accuracy consult your local service center for guidance.) The zero is now set and full scale adjustments may now be made.
4. Set the input level to +190.00mV. Adjust R131 for a reading of 19000 digits.
5. Set the input level to –190.00mV. Adjust R137 for a reading of –19000 digits.

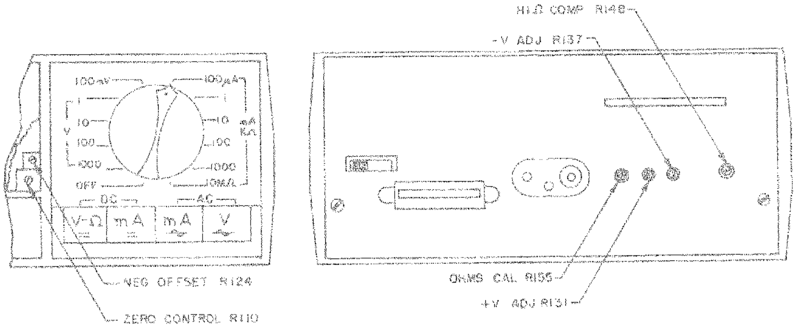


Figure 22. Calibration

6. Set the range to 1 volt and apply +1.9000 volts. The display should read 1.9000 within rated accuracy. If not, the user has the option of offsetting the full scale adjustments to split the errors so that both ranges will be within specification or resorting to an internal gain adjustment which should have the guidance either from the factory or the local field service center.
7. Ohms calibration — Depress the DC V—Ω button and set the range switch to the 100KΩ position. Connect the test leads to a standard resistor of some value below 200KΩ but as high as possible for good setting resolution. Adjust R155 for a reading corresponding to the standard.
8. 10 Megohm range — Set the range switch to the 10MΩ position and measure a 10 megohms standard. Adjust R148 for a face value reading. Since settling time is long for the 10MΩ range, rotate R148 in small increments and wait for the display to settle.
9. DC current accuracy is controlled by fixed resistors and is not adjustable.
10. AC calibration requires internal adjustments. Consult the factory or your local service center.
11. AC current calibration is the product of items 9 and 10 above and requires internal adjustments.

DRAWINGS AND PARTS LIST

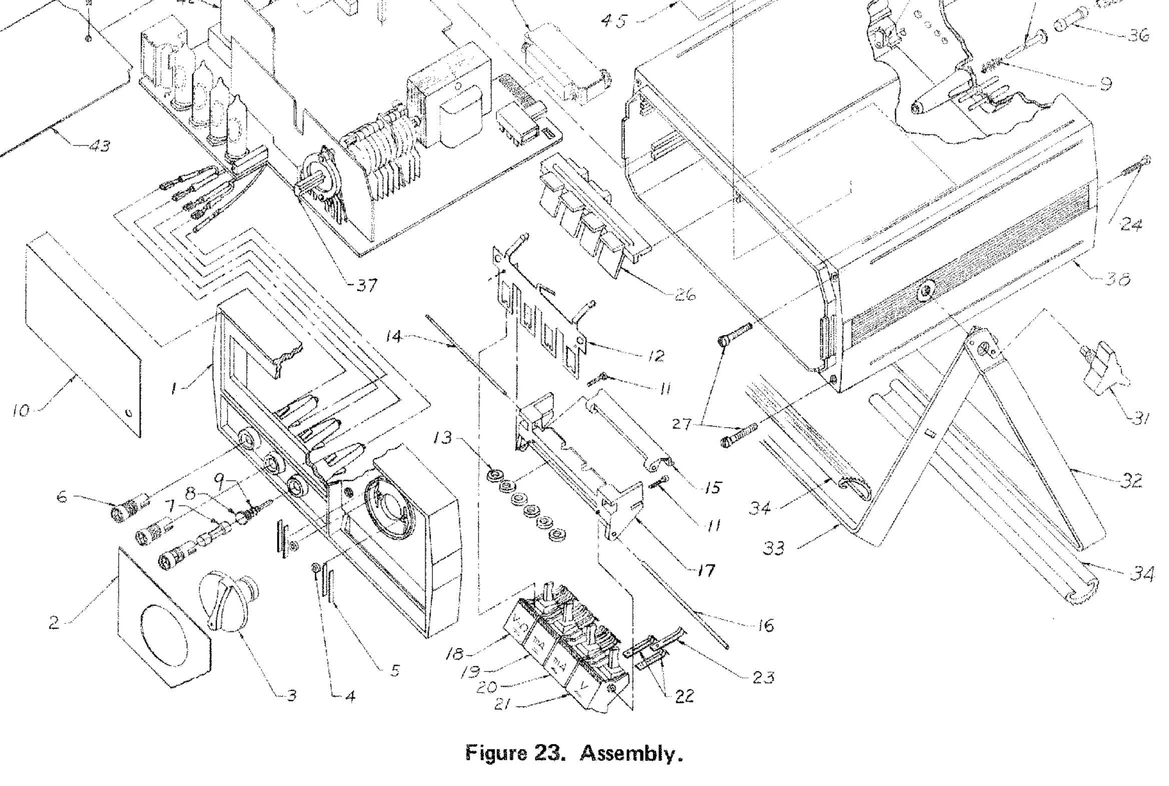


Figure 23. Assembly.

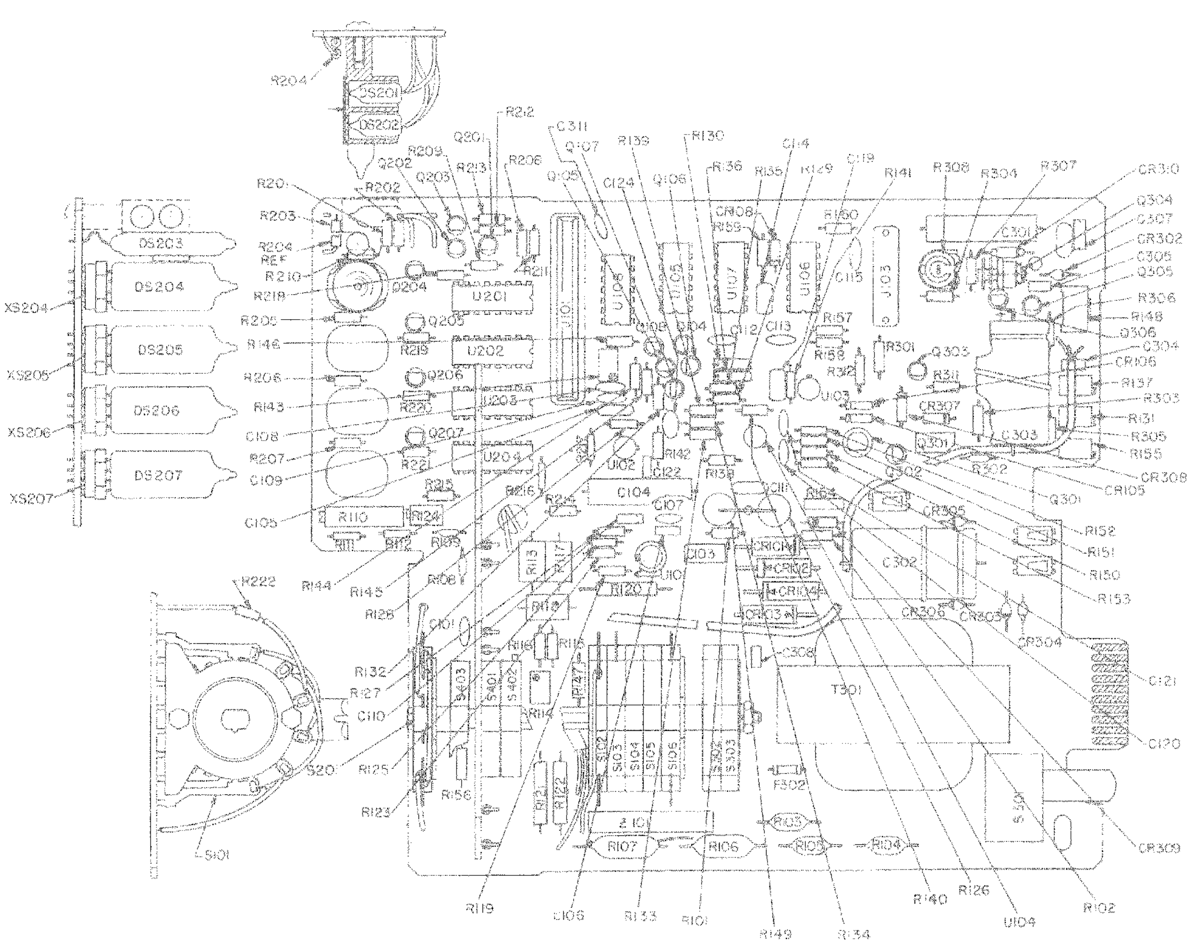


Figure 24. Board Assembly

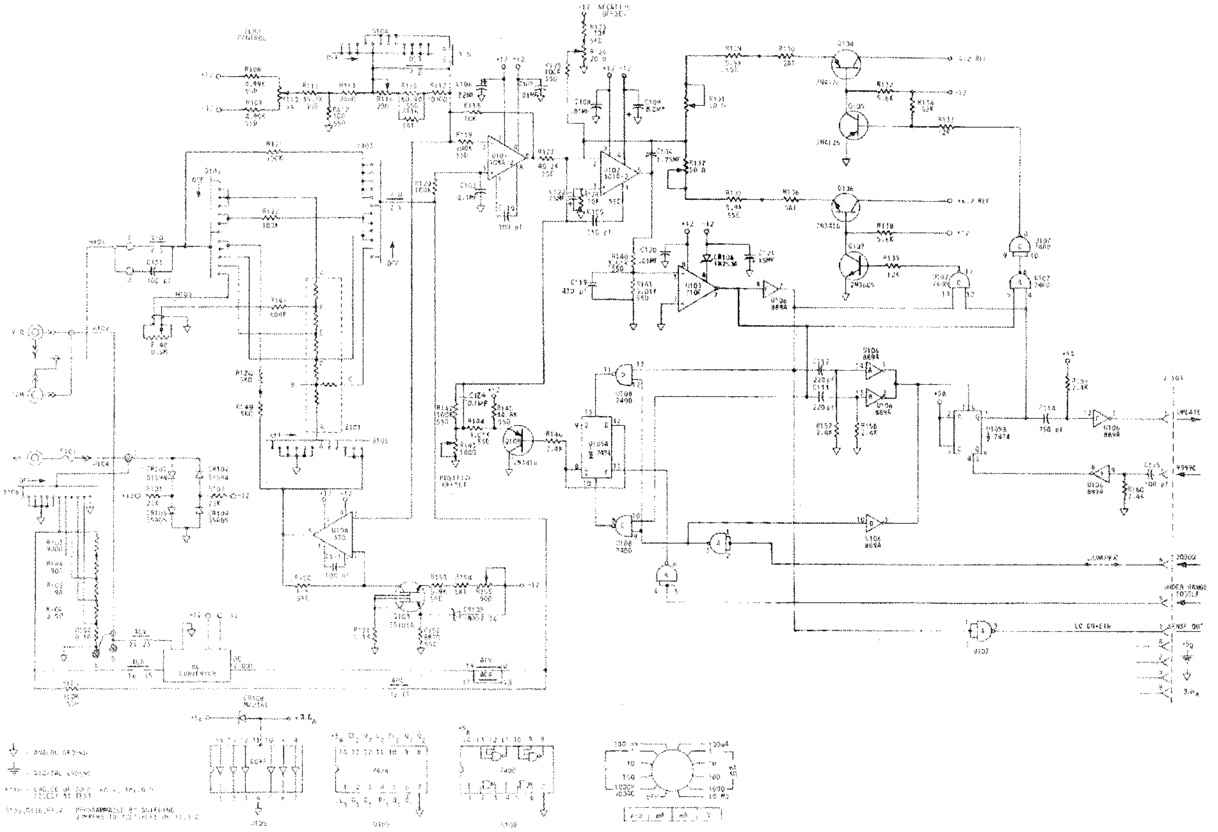
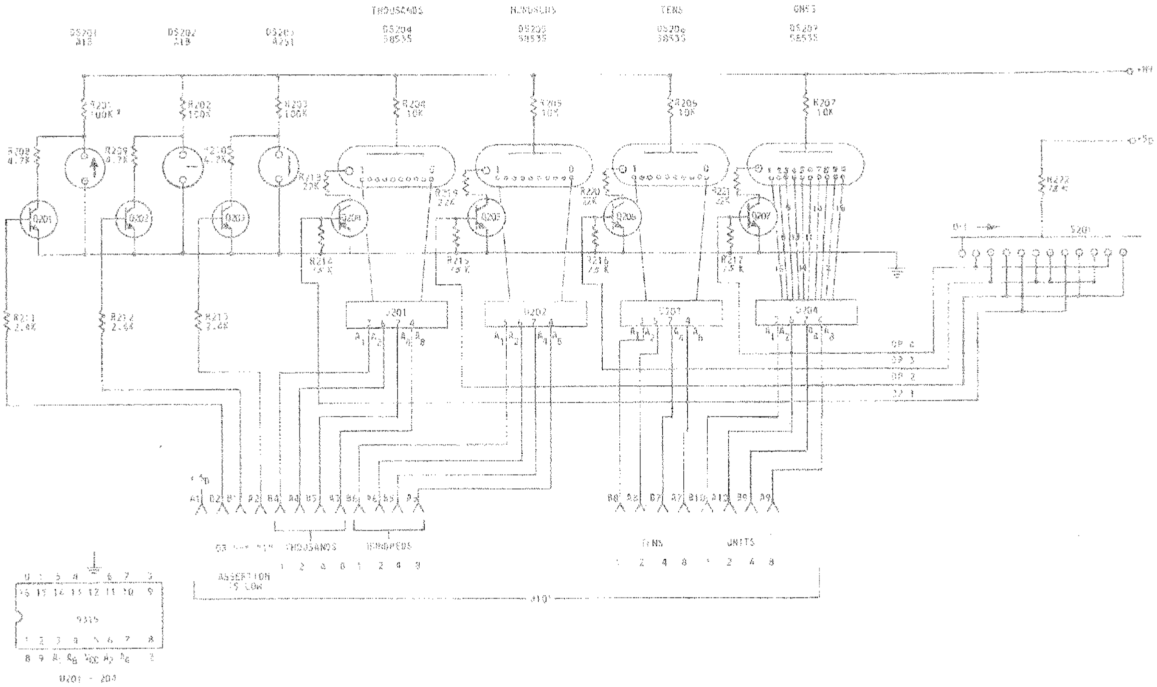


Figure 25. Schematic Diagram, Analog Section



ALL TRANSISTORS 2N5175

ALL RESISTORS - 1/4W COR

THIS CIRCUITRY FOUND ON MOTHER BOARD

WILL INTERCONNECT WITH 271829-901

S201 PART OF SWITCH ASSEMBLY 271831-901

Figure 26. Schematic Diagram, Display Circuit

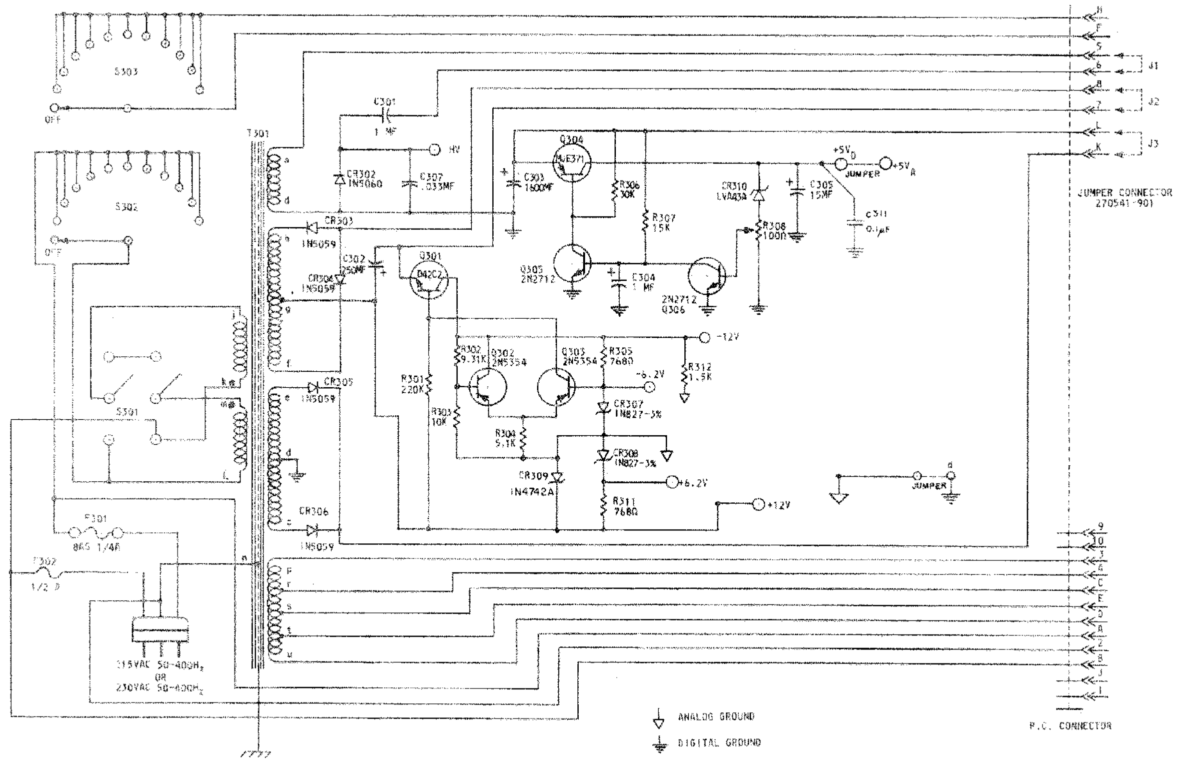


Figure 27. Schematic Diagram, Power Supply

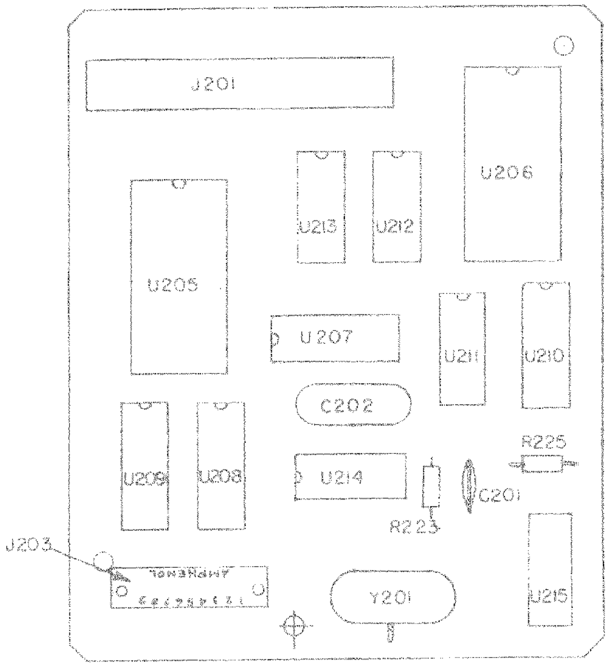


Figure 28. Board Assembly, Logic

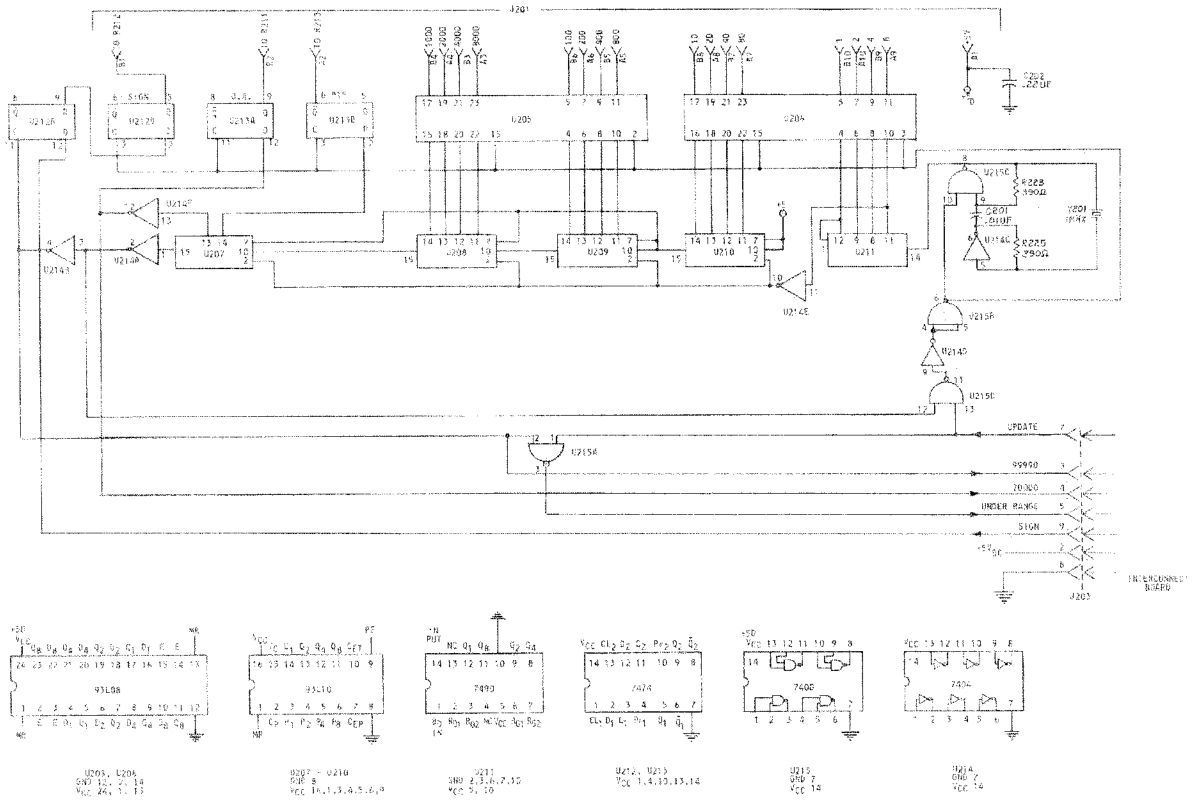


Figure 29. Schematic Diagram, Logic Section

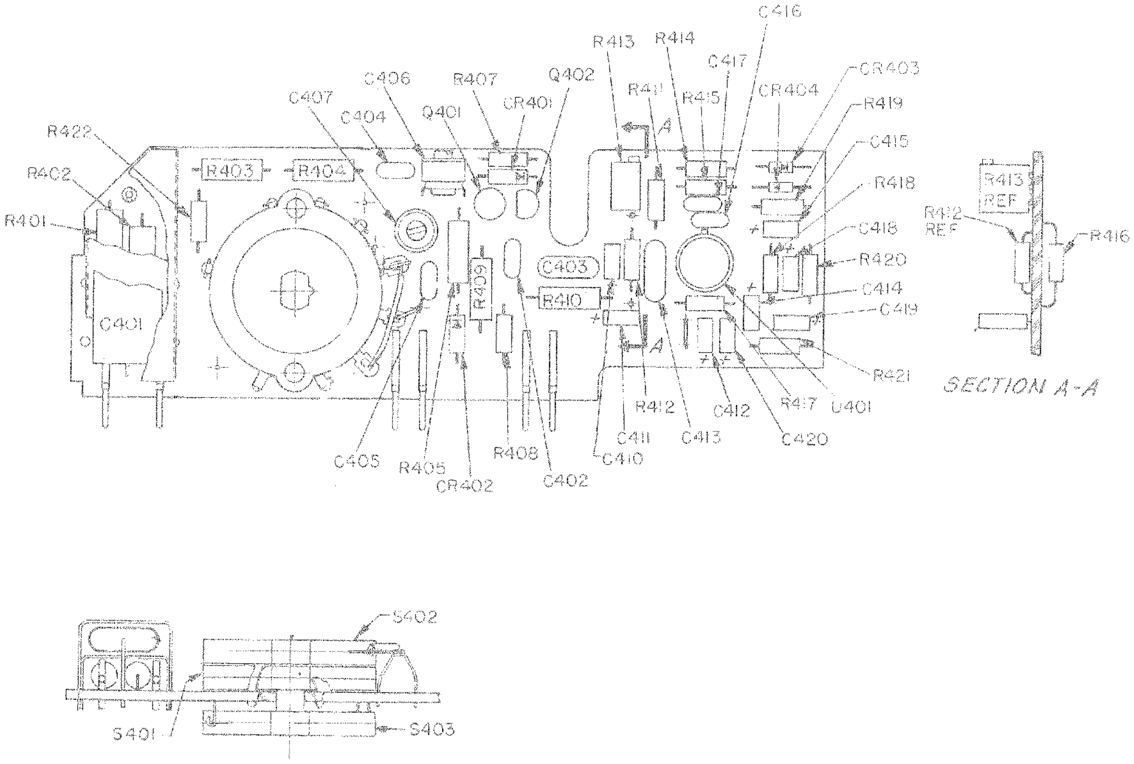
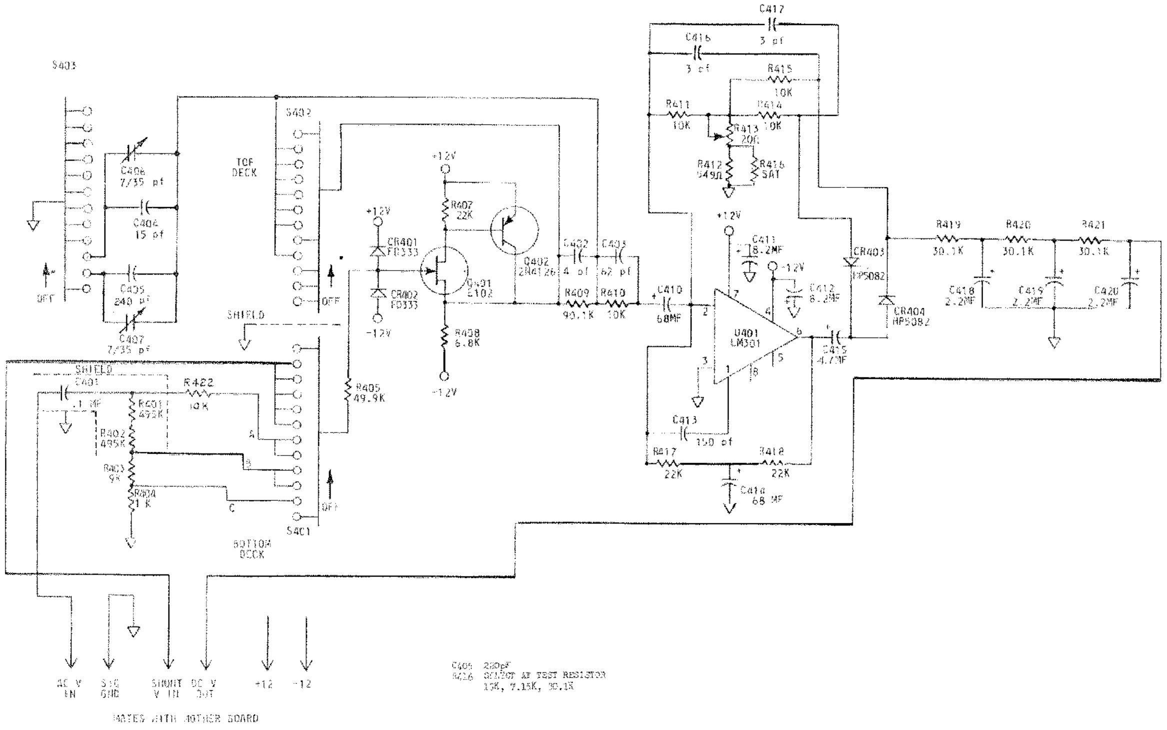


Figure 30. Board Assembly, AC Converter



C405 220pF
R416 SELECT AT TEST RESISTOR
15K, 7.15K, 30.1K

Figure 31. Schematic Diagram, AC Converter

PARTS LIST

ASSEMBLY (Ref Figure 23)

ITEM NO.	DESCRIPTION	WESTON PART NO.
1	FRONT, MOLDED	267327-903
2	DIAL, PRINTED	271795-901
3	KNOB	267331-901
4	ROLLER, DETENT	267334-001
5	SPRING, DETENT	267333-001
6	SOCKET, BANANA PLUG	267330-024
7	FUSE, INPUT, 3 AMP, 8AG	269938-001
8	CONTACT, BANANA PLUG	269062-001
9	SPRING	270006-172
10	WINDOW	267328-907
11	SCREW	ND27395-045
12	SPRING, BUTTON RETURN	267338-001
13	ROLLER, INTERLOCK	267337-001
14	SHAFT, LOCK	267341-001
15	LOCK, BUTTON	267340-001
16	SHAFT, BUTTON	267339-001
17	SUPPORT, INTERLOCK	267336-001
18	BUTTON, SWITCH, V $-\underset{=}{\Omega}$	270975-903
19	BUTTON, SWITCH $\underset{=}{\mathrm{mA}}$	270975-901
20	BUTTON, SWITCH $\underset{\infty}{\mathrm{mA}}$	270975-902
21	BUTTON, SWITCH $\underset{\infty}{\mathrm{V}}$	270975-904

PARTS LIST

ITEM NO.	DESCRIPTION	WESTON PART NO.
	ASSEMBLY Cont. (Ref Figure 23)	
22	CONTACT, OUTER	267342-077
23	CONTACT, CENTER	267343-077
24	SCREW, Circuit Board Mtg	266623-045
25	CLAMP, Circuit Board Mtg	265661-024
26	CLAMP, TUBE	271800-001
27	SCREW, Panel Mtg	ND32910-024
28	LEAD ASSY, TEST (Not shown)	270066-001
29	LINE CORD (Not shown)	269985-001
30	KNOB, HANDLE	269546-001
31	KNOB, HANDLE	269547-001
32	HANDLE, REAR	267346-366
33	HANDLE, FRONT	267345-366
34	GRIP, HANDLE	267347-902
35	CONNECTOR ASSY	270541-901
36	FUSE, AC PLUG, 1/4 AMP 8AG	ND29787-001
37	SHAFT, RANGE SWITCH	269436-001
38	CASE	269444-901
39	PIN, AC FUSE	269066-001
40	BOARD ASSY	271810-901
41	BOARD, INTERCONNECT, REAR	271846-901
42	BOARD, INTERCONNECT, FRONT	271845-901
43	BOARD ASSY, LOGIC	271829-901
44	SCREW	ND24126-024
45	SHIELD ASSY	271891-901

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY (Ref Figure 24 thru 27)	
C101	CAPACITOR, 100pF, 1000 WVDC	264089-001
C103	CAPACITOR, 0.1 μF, 250 WVDC	269900-001
C104	CAPACITOR, 1.75 μF, 100 WVDC	269897-001
C105	CAPACITOR, 150 pF, 500 WVDC	265869-001
C106	CAPACITOR, 22 μF, 150 WVDC	274269-001
C107	CAPACITOR, 0.01 μF, 50 WVDC	269899-001
C108	CAPACITOR, 0.01 μF, 50 WVDC	269899-001
C109	CAPACITOR, 8.2 μF, 15 WVDC	269952-001
C110	CAPACITOR, 100 pF, 1000 WVDC	264089-001
C111	CAPACITOR, 100 pF, 1000 WVDC	264089-001
C112	CAPACITOR, 200 pF, 1000 WVDC	264091-001
C113	CAPACITOR, 200 pF, 1000 WVDC	264091-001
C114	CAPACITOR, 750 pF, 500 WVDC	265884-001
C115	CAPACITOR, 100 pF, 1000 WVDC	264089-001
C119	CAPACITOR, 430 pF, 500 WVDC	270079-001
C120	CAPACITOR, 0.01 μF, 50 WVDC	269899-001
C121	CAPACITOR, 8.2 μF, 15 WVDC	269952-001
C122	CAPACITOR, 15 μF, 10 WVDC	269951-001
C124	CAPACITOR, 0.1uF, 10 WVDC	272376-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
C301	CAPACITOR, 1 μF, 200 WVDC	269895-001
C302	CAPACITOR, 250μF, 64 WVDC	266349-001
C303	CAPACITOR, 1600 μF, 10 WVDC	266607-001
C304	CAPACITOR, 1 μF, 35 WVDC	269954-001
C305	CAPACITOR, 15 μF, 10 WVDC	269951-001
C307	CAPACITOR, 0.033 μF, 200 WVDC	272881-001
C311	CAPACITOR, 0.1 μF, 10 WVDC	272376-001
CR101	DIODE, S1594	272775-001
CR102	DIODE, S1594	272775-001
CR103	DIODE, S5A05	272364-001
CR104	DIODE, S5A05	272364-001
CR105	DIODE, 1N827–3%	272774-001
CR106	DIODE, 1N753A	264699-001
CR108	DIODE, MZ2361	272830-001
CR302	DIODE, 1N5060	266591-001
CR303	DIODE, 1N5059	266611-001
CR304	DIODE, 1N5059	266611-001
CR305	DIODE, 1N5059	266611-001
CR306	DIODE, 1N5059	266611-001
CR307	DIODE, 1N827–3%	272774-001
CR308	DIODE, 1N827–3%	272774-001
CR309	DIODE, 1N4742A	264601-001
CR310	DIODE, LV43A	272737-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
DS201	LAMP, GE A1B	269877-001
DS202	LAMP, GE A1B	269877-001
DS203	LAMP, NEON, SIGNALITE A261	266537-001
DS204	TUBE, READOUT, BURROUGHS B5853S	272589-001
DS205	TUBE, READOUT, BURROUGHS B5853S	272589-001
DS206	TUBE, READOUT, BURROUGHS B5853S	272589-001
DS207	TUBE, READOUT, BURROUGHS B5853S	272589-001
F302	FUSE, 1/2 AMP, LITTELFUSE 276.500	272753-001
J101	CONNECTOR	272779-001
J103	CONNECTOR, AMPHENOL 64–17	272780-001
Q103	INTEGRATED CIRCUIT, TD101A	266399-001
Q104	TRANSISTOR, 2N4126	269956-001
Q105	TRANSISTOR, 2N4126	269956-001
Q106	TRANSISTOR, 2N3416	263642-001
Q107	TRANSISTOR, 2N3605	268796-001
Q108	TRANSISTOR, 2N3416	263642-001
Q201	TRANSISTOR, 2N5175	266585-001
Q202	TRANSISTOR, 2N5175	266585-001
Q203	TRANSISTOR, 2N5175	266585-001
Q204	TRANSISTOR, 2N5175	266585-001
Q205	TRANSISTOR, 2N5175	266585-001
Q206	TRANSISTOR, 2N5175	266585-001
Q207	TRANSISTOR, 2N5175	266585-001

PARTS LIST

BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)

REF SYMBOL	DESCRIPTION	WESTON PART NO.
Q301	TRANSISTOR, D42C2N	269902-001
Q302	TRANSISTOR, 2N5354	268795-001
Q303	TRANSISTOR, 2N5354	268795-001
Q304	TRANSISTOR, MJE371	266343-001
Q305	TRANSISTOR, 2N2712	39917-001
Q306	TRANSISTOR, 2N2712	39917-001
R101	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R102	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R103	RESISTOR, 900 ohms, ±0.1%, 1/4 watt	269942-001
R104	RESISTOR, 90 ohms, ±0.1%, 1/4 watt	269941-001
R105	RESISTOR, 9 ohms, ±0.1%, 1/4 watt	269940-001
R106	RESISTOR, 0.9 ohm, ±0.1%, 1/2 watt	269939-001
R107	RESISTOR, 0.1 ohms, ±0.1%, 2-1/2 watt	269943-001
R108	RESISTOR, 4.99K ohms, ±1%, 1/10 watt	269911-001
R109	RESISTOR, 4.99K ohms ±1%, 1/10 watt	269911-001
R110	RESISTOR, VARIABLE, 5K ohms, ±10%, 1 watt	269919-001
R111	RESISTOR, 35.7K ohms, ±1%, 1/10 watt	270158-001
R112	RESISTOR, 10 ohms, ±1%, 1/10 watt	269915-001
R113	RESISTOR, 246 ohms, ±0.5%, .166 watt	272763-001
R114	RESISTOR, VARIABLE, 20 ohms, ±5%, .6 watt	272805-001
R115	RESISTOR, 60.4 ohms, ±1%, 1/10 watt	272770-001
R116	RESISTOR, KIT	271820-901
R117	RESISTOR, 3030 ohms, ±0.5%, .166 watt	272761-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
R118	RESISTOR, 10K ohms, ±0.5%, .166 watt	272762-001
R119	RESISTOR, 200K ohms, ±1%, 1/10 watt	272768-001
R120	RESISTOR, 100K ohms, ±1%, 3/4 watt	269912-001
R121	RESISTOR, 100K ohms, ±1%, 3/4 watt	269912-001
R122	RESISTOR, 100K ohms ±1%, 3/4 watt	269912-001
R123	RESISTOR, 10K ohms, ±1%, 1/10 watt	269887-001
R124	RESISTOR, VARIABLE, 20 ohms, ±5%, .6 watt	272781-001
R125	RESISTOR, 100K ohms, ±1%, 1/10 watt	269885-001
R126	RESISTOR, 5K ohms, ±0.2%	274174-001
R127	RESISTOR, 40.1K ohms, ±1%, 1/10 watt	272773-001
R128	RESISTOR, 10K ohms, ±1%, 1/10 watt	269887-001
R129	RESISTOR, 5.9K ohms, ±1%, 1/10 watt	272772-001
R130	RESISTOR, NETWORK TRIMMING	271853-001
R131	RESISTOR, VARIABLE, 50 ohms, ±5%, .6 watt	270003-001
R132	RESISTOR, 5.6K ohms, ±5%, 1/4 watt	265819-001
R133	RESISTOR, 12K ohms, ±5%, 1/4 watt	266613-001
R134	RESISTOR, 62K ohms, ±5%, 1/4 watt	263651-001
R135	RESISTOR, 5.9K ohms, ±1%, 1/10 watt	272772-001
R136	RESISTOR, NETWORK TRIMMING	271853-001
R137	RESISTOR, VARIABLE, 50 ohms, ±5%	270003-001
R138	RESISTOR, 5.6K ohms, ±5%, 1/4 watt	265819-001
R139	RESISTOR, 12K ohms, ±5%, 1/4 watt	266613-001
R140	RESISTOR, 3.01K ohms, ±1%, 1/10 watt	272217-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
R141	RESISTOR, 3.01K ohms, ±1%, 1/10 watt	272217-001
R142	RESISTOR, 100K ohms, ±1%, 1/10 watt	269885-001
R143	RESISTOR, VARIABLE, 100 ohms, ±5%,	272807-001
R144	RESISTOR, 3.01K ohms, ±1%, 1/10 watt	272217-001
R145	RESISTOR, 44.8K ohms, ±1%, 1/10 watt	272213-001
R146	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R147	RESISTOR, 604K ohms, ±1%, 1/10 watt	272765-001
R148	RESISTOR, VARIABLE, 0.5 megohms, ±10%, 1 watt	272777-001
R149	RESISTOR, 5K ohms, ±.02%, 3 watt	274174-001
R150	RESISTOR, 1K ohms, ±1%, 1/10 watt	272771-001
R151	RESISTOR, 5.1K ohms, ±5%, 1/4 watt	37341-001
R152	RESISTOR, 887 ohms, ±1%, 1/10 watt	272769-001
R153	RESISTOR, 5.9K ohms, ±1%, 1/10 watt	272772-001
R154	RESISTOR, NETWORK TRIMMING	271853-001
R155	RESISTOR, VARIABLE, 50 ohms, ±5%,	270003-001
R156	RESISTOR, 100K ohms, ±1%, 1/10 watt	269885-001
R157	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R158	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R159	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R160	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R201	RESISTOR, 100K ohms, ±5%, 1/4 watt	266592-001
R202	RESISTOR, 100K ohms, ±5%, 1/4 watt	266592-001
R203	RESISTOR, 100K ohms, ±5%, 1/4 watt	266592-001
R204	RESISTOR, 10K ohms, ±5%, 1/4 watt	264673-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
R205	RESISTOR, 10K ohms, ±5%, 1/4 watt	264673-001
R206	RESISTOR, 10K ohms, ±5%, 1/4 watt	264673-001
R207	RESISTOR, 10K ohms, ±5%, 1/4 watt	264673-001
R208	RESISTOR, 4.7K ohms, ±5%, 1/4 watt	263652-001
R209	RESISTOR, 4.7K ohms, ±5%, 1/4 watt	263652-001
R210	RESISTOR, 4.7K ohms, ±5%, 1/4 watt	263652-001
R211	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R212	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R213	RESISTOR, 2.4K ohms, ±5%, 1/4 watt	266615-001
R214	RESISTOR, 15K ohms, ±5%, 1/4 watt	263655-001
R215	RESISTOR, 15K ohms, ±5%, 1/4 watt	263655-001
R216	RESISTOR, 15K ohms, ±5%, 1/4 watt	263655-001
R217	RESISTOR, 15K ohms, ±5%, 1/4 watt	263655-001
R218	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R219	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R220	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R221	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R222	RESISTOR, 12K ohms, ±5%, 1/4 watt	266613-001
R301	RESISTOR, 220K ohms, ±5%, 1/4 watt	264672-001
R302	RESISTOR, 9.31K ohms, ±1%, 1/10 watt	272236-001
R303	RESISTOR, 10K ohms, ±1%, 1/10 watt	266627-001
R304	RESISTOR, 5.1K ohms, ±5%, 1/4 watt	37341-001
R305	RESISTOR, 768 ohms, ±1%, 1/8 watt	272872-001
R306	RESISTOR, 30K ohms, ±5%, 1/4 watt	269908-001
R307	RESISTOR, 15K ohms, ±5%, 1/4 watt	263655-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
R308	RESISTOR, VARIABLE, 100 ohms, ±20%, 0.1 watt	272808-001
R311	RESISTOR, 768 ohms, ±1%, 1/8 watt	272872-001
R312	RESISTOR, 1.5K ohms, ±5%, 1/4 watt	264677-001
S101	SWITCH ASSY (Consists of S102 to S106, S201, S302, S303, S401 to S403)	271831-901
S102	DECK, SWITCH	271822-901
S103	DECK, SWITCH	271823-901
S104	DECK, SWITCH	271824-901
S105	DECK, SWITCH	271825-901
S106	DECK, SWITCH	271826-901
S201	DECK, SWITCH	271821-001
S301	SWITCH, DPDT, SLIDE	272371-001
S302	DECK, SWITCH	271828-901
S303	DECK, SWITCH	271828-901
T301	TRANSFORMER, POWER	271864-901
U101	AMPLIFIER, 308A–2	271818-001
U102	AMPLIFIER, 101A–2	271852-001
U103	INTEGRATED CIRCUIT, 710C	269903-001
U104	AMPLIFIER, 308	271819-001
U105	MICROCIRCUIT 7474	272749-001
U106	INTEGRATED CIRCUIT MC889AP	272776-001
U107	MICROCIRCUIT 7400	272264-001
U108	MICROCIRCUIT 7400	272264-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	BOARD ASSEMBLY Cont. (Ref Figure 24 thru 27)	
U201	MICROCIRCUIT 9315	272748-001
U202	MICROCIRCUIT 9315	272748-001
U203	MICROCIRCUIT 9315	272748-001
U204	MICROCIRCUIT 9315	272748-001
W101	LEAD, SHIELDED	271865-901
W102	LEAD, SHIELDED	271865-902
W103	CABLE, SHIELDED	271866-901
W104	LEAD, WHITE	269442-901
XS101	SOCKET, INTEGRATED CIRCUIT, 8058–1G32	270031-001
XS204	SOCKET, READOUT TUBE, BURROUGHS SK207	266602-001
XS205	SOCKET, READOUT TUBE, BURROUGHS SK207	266602-001
XS206	SOCKET, READOUT TUBE, BURROUGHS SK207	266602-001
XS207	SOCKET, READOUT TUBE, BURROUGHS SK207	266602-001
Z101	ATTENUATOR	271799-001
—	BOARD, DRILLED	271809-901

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOGIC BOARD (Ref Figures 28 & 29)	
C201	CAPACITOR, .01µF, 50 WVDC	269899-001
C202	CAPACITOR, .22µF, 250 WVDC	272263-001
J201	CONNECTOR, VIKING 2VK10D/2–12	272779-001
J203	CONNECTOR, AMPHENOL 64–17	272780-001
R223	RESISTOR, 390 ohms, ±5%, 1/4 watt	272246-001
R225	RESISTOR, 390 ohms, ±5%, 1/4 watt	272246-001
U205	MICROCIRCUIT, 93L08	272730-001
U206	MICROCIRCUIT, 93L08	272730-001
U207	MICROCIRCUIT, 93L10	272751-001
U208	MICROCIRCUIT, 93L10	272751-001
U209	MICROCIRCUIT, 93L10	272751-001
U210	MICROCIRCUIT, 93L10	272751-001
U211	MICROCIRCUIT, 7490	272267-001
U212	MICROCIRCUIT, 7474	272749-001
U213	MICROCIRCUIT, 7474	272749-001
U214	MICROCIRCUIT, 7404	272759-001
U215	MICROCIRCUIT, 7400	272264-001
Y201	CRYSTAL, QUARTZ 1MHz	271954-902
—	BOARD, DRILLED	271832-901

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	AC CONVERTER (Ref Figures 30 & 31)	
C401	CAPACITOR, 0.1 µF @ 630 V	270014-001
C402	CAPACITOR, 4 pF ±1/2%	269948-001
C403	CAPACITOR 62 pF ±2%	274127-001
C404	CAPACITOR, 15 pF ±5%	274126-001
C405	CAPACITOR, Factory selected	273811-901
C406	CAPACITOR, TRIMMER, 7–35 µF	274125-001
C407	CAPACITOR, TRIMMER, 7–35 µF	274124-001
C410	CAPACITOR, 68 µF @ 6 V	274153-001
C411	CAPACITOR, 8.2 µF @ 15 V	269952-001
C412	CAPACITOR, 8.2 µF @ 15 V	269952-001
C413	CAPACITOR, 1 pF	265869-001
C414	CAPACITOR, 68 µF @ 6 V	274153-001
C415	CAPACITOR, 4.7 µF @ 10 V	272883-001
C416	CAPACITOR, 3 pF	269947-001
C417	CAPACITOR, 3 pF	269947-001
C418	CAPACITOR, 2.2 µF @ 35 V	269953-001
C419	CAPACITOR, 2.2 µF @ 35 V	269953-001
C420	CAPACITOR, 2.2 µF @ 35 V	269953-001
CR401	DIODE, FD333	269922-001
CR402	DIODE, FD333	269922-001
CR403	DIODE, HP5082–2800	269959-001
CR404	DIODE, HP5082–2800	269959-001
Q401	TRANSISTOR, FET E102	269958-001
Q402	TRANSISTOR, 2N4126	269956-001

PARTS LIST

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	AC CONVERTER (Ref Figures 30 & 31)	
R401	RESISTOR, 495K ohms	
R402	RESISTOR, 495K ohms Resistor	274137-001
R403	RESISTOR, 9K ohms Package	
R404	RESISTOR, 1K ohms SPR–687	
R405	RESISTOR, 49.9K ohms, ±1%, 1/8 watt	270028-001
R407	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R408	RESISTOR, 6.8K ohms, ±5%, 1/4 watt	269891-001
R409	RESISTOR, 90.1K ohms Resistor	
R410	RESISTOR, 10K ohms Package	269984-001
	SPR 457–B	
R411	RESISTOR, 10K ohms, ±1%, 1/10 watt	274107-001
R412	RESISTOR, 549 ohms, ±1%, 1/10 watt	274108-001
R413	RESISTOR, VARIABLE, 20 ohms, ±5%, .6 watt	272781-001
R414	RESISTOR, 10K ohms, ±1%, 1/10 watt	274107-001
R415	RESISTOR, 10K ohms, ±1%, 1/10 watt	274107-001
R416	RESISTOR, Factory selected	273107-901
R417	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R418	RESISTOR, 22K ohms, ±5%, 1/4 watt	264674-001
R419	RESISTOR, 30.1K ohms, ±1%, 1/10 watt	269931-001
R420	RESISTOR, 30.1K ohms, ±1%, 1/10 watt	269931-001
R421	RESISTOR, 30.1K ohms, ±1%, 1/10 watt	269931-001
R422	RESISTOR, 10K ohms, ±1%, 1/10 watt	269887-001
S401	DECK, RANGE SWITCH	271859-001
S402	DECK, RANGE SWITCH	271860-001
S403	DECK, RANGE SWITCH	271877-001
–	BOARD, DRILLED	271838-901

WESTON EQUIPMENT WARRANTY

Weston warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Weston equipment, at an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) Upon receipt of written authorization from Seller the defective equipment is returned as directed, transportation charges prepaid by Buyer, and, (c) Seller's examination of such equipment discloses to his satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as tubes, lamps, etc.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose to the original purchaser or to any other person. Seller shall not be liable for consequential damages of any kind.

The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Seller.

NOTES